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RADIATION CONTAMINATION CLEARANCE REPORT

June, 1977

Prepared for

U. S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
NEVADA OPERATIONS OFFICE
BY EBERLINE INSTRUMENT CORPORATION
UNDER CONTRACT TO AUSTRAL OIL COMPANY

eberline

RULISON

RADIATION CONTAMINATION CLEARANCE REPORT

by

Eberline Instrument Corporation
Santa Fe, New Mexico 87501

UNDER CONTRACT WITH AUSTRAL OIL COMPANY

Date Published — June 1977

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ABSTRACT

Under contract with Austral Oil Company, Eberline Instrument Corporation provided supervision and technicians to radiologically support the well plugging and site abandonment activities at the Project Rulison site during the period September 1, 1976 through October 12, 1976. The purpose of the support was to identify and prepare for removal of all radioactively contaminated materials remaining on site.

The emplacement and reentry wells were successfully plugged without a serious radiological incident. There was no measurable radiation exposure above natural background to participating personnel.

Decontamination and monitoring procedures assured that no equipment or material was improperly released to unrestricted use.

A review of the history of project operations, the conduct of comprehensive sampling programs, and an extensive final survey, ensures that the extent of radioactivity on the site is identified and that such activity is well below established guide lines.

Except for appropriate restrictions regarding deep drilling, the radiological condition of the Project Rulison site permits its return to unrestricted use.

1. Introduction

Project Rulison, the second nuclear gas stimulation experiment, co-sponsored by the U. S. Atomic Energy Commission, USAEC (now the U. S. Energy Research and Development Administration ERDA), and the Austral Oil Company, was designed to determine the potential increase in production by using a nuclear explosive to stimulate and enhance natural gas recovery in the Mesaverde formation of the Rulison Field, Garfield County, Colorado (see Figure 1).

On September 10, 1969, under the technical direction of the Los Alamos Scientific Laboratory (LASL), a 43 kiloton fission-type nuclear explosive was detonated at a depth of 8,426 feet in an Emplacement well (designated R-E) on Colorado's western slope. Re-entry drilling operations, through a separate Re-Entry well (designated R-EX) located 300 feet southeast of the emplacement well, began in April and were completed in July of 1970. This re-entry was designed to production test the stimulated zone.

Production testing took place over a seven month period and included four separate flow periods. Between October 1970 and April 1971, approximately 455 million standard cubic feet (MMSCF) of chimney gas was produced.

The well was shut-in after the last test in April 1971, and left in a standby condition (see Figure 2) until a general cleanup was undertaken in 1972. Cleanup work at the site commenced on July 10, 1972, and was completed on July 25, 1972. The purpose was to decontaminate, if necessary, and remove from the site all equipment and materials not needed for possible future gas production (see Figure 3). The task was accomplished and the radiological condition of the site was documented by extensive instrumentation and soil sampling techniques. The Rulison Site Cleanup Report, NVO-136, September 1973, is recommended for further details.

Neither the Austral Oil Company nor ERDA have any plans to commercially produce the available chimney gas. Accordingly, during the period September 1, 1976 through October 12, 1976, the R-E and R-EX wells were plugged and abandoned, and the equipment that remained after the 1972 general cleanup was decontaminated if necessary, and removed from the site. Eberline Instrument Corporation furnished radiological support to the Austral Oil Company at the well site during both the general and the final cleanup operations.

2. Purpose

The purpose of this report is to identify the extent of radioactive contamination of site property pursuant to the requirements of ERDA Manual Appendix 5301. Results of the general cleanup, reported by the Rulison Site Cleanup Report, NVO-136, September 1973, are recapitulated and included with the final cleanup data to combine all radiation contamination clearance information in this single volume.

3. Disposal of Radioactively Contaminated Material

No burial of radioactive solids was attempted at the Rulison site. Radioactive nuclide particulates resulting from the detonation are contained in the detonation-formed cavity. On October 4, 1976, 0.166 Ci of tritium in waste water and drilling mud were pumped into the Mesaverde formation at a depth of approximately 5300 to 5800 feet for disposal. It should be noted that the potable aquifers above this depth were previously cemented off during emplacement drilling.

Contaminated material and soil resulting from the general and the final cleanups were shipped to Beatty, Nevada for burial at the Nuclear Engineering Company facility. On July 20, 1972, 3000 gallons of fluid containing 0.69 Ci of tritium were shipped by tank truck. On July 22, 1972, 32 packages of contaminated solid waste and six 55-gallon steel drums of solidified liquid waste, both containing an estimated 73 mCi of tritium were shipped. On October 8, 1976, as a result of the final cleanup, sixty eight 55-gallon steel drums of contaminated soil and other solid waste containing a total of 0.018 Ci of tritium were shipped. The total amount of tritium shipped to burial from the Rulison site as a result of both the general and final cleanup operations was estimated to be 0.781 Ci. No other radioactive nuclide was involved in either cleanup.

4. Personnel Monitoring and Bioassay

All personnel participating in the general cleanup in July 1972 wore thermoluminescent dosimeters (TLD's). During the final cleanup, only technicians who might be required to work with radiation calibration sources were required to wear these dosimeters. In both cases, the dosimeters were read and analyzed at the Eberline facility in Santa Fe, New Mexico. No exposure to radiation above natural background was detected.

Baseline urine samples were collected from all participants in cleanup activities. Samples were collected again upon completion of each individual's participation. These samples were analyzed on site for tritium by liquid scintillation with a detection sensitivity of 10 pCi/ml. No tritium was detected in these samples.

Participants in the general (1972) or final (1976) cleanup received no measurable radiation exposure due to their participation.

5. Radiation Monitoring Equipment

During the general site cleanup in 1972, a mobile radiation measurement trailer was located on the R-EX well level at the site. This trailer contained a liquid scintillation system, a gamma spectrometry system, and a gross alpha-beta counting system. The Rulison re-entry wellhead shack was used as an improvised sample preparation area. The following types of portable survey instruments were used:

a. Eberline E-400 with HP-177 probe — a low range beta-gamma detection instrument.

b. Eberline E-400 with HP-210 probe — a low range beta-gamma detection instrument using an absorber of less than 7 mg/cm^2.

c. Eberline PRM-4 with HP-210 probe — a pulse rate instrument using an absorber of less than 7 mg/cm^2.

d. Eberline PRM-5 with SPA-2 probe — a pulse rate instrument with a 1" x 2" crystal detector.

During the final site cleanup in 1976, the same radiation measurements trailer was employed at the Rulison Control Point (C.P.) about two miles down the road from the well location. A mobile sample preparation trailer was located at the C. P. to operate in conjunction with the measurements trailer. An instrument trailer belonging to the El Paso Natural Gas Company was used as an office at the R-EX well location and to provide a backup capability for prompt tritium analysis by liquid scintillation counting. A sample preparation capability was maintained on the well location in an ERDA owned instrument van. The portable instruments named above were also used during the final cleanup.

Supplementary items such as glassware, tools, plastic containers, and anti-contamination clothing were used as needed during both the general and final cleanup.

6. Decontamination Effort

The decontamination effort at the Rulison site was divided into two separate and distinct operations: the general cleanup in 1972 and the final cleanup in 1976. Tritium was the only contaminant detected.

6.1 General Cleanup Effort (July 10 through 25, 1972)

Prior to this cleanup, the site was in standby condition with all surface equipment intact. The capability to perform gas production tests by flaring remained in standby status.

During this cleanup, all items of equipment and material that were not required for production testing were removed from the site. A release log was maintained to describe each item and to record its radiological condition if it was to be released for unrestricted use. There were 504 uncontaminated and decontaminated items logged and released. Items that could not be economically decontaminated were included in the material shipped for burial (see paragraph 3). Decontamination operations were conducted in a large sheet-metal pan using saturated steam and Steamzall, a Turco product. The guideline limits for release of material were 1000 cpm beta-gamma removable from any 100 cm^2, and a total of 0.4 mrad/hr at 1 cm from the surface, through not more than a 7 mg/cm^2 absorber. In practice the actual removable contamination for released items was always well below the guideline and the reading in each case was not above background (0.02 mrad/hr) of the site area.

Upon completion of the 1972 general cleanup, the following equipment was left on the site:

a. The emplacement well (R-E) equipped with high pressure wellhead equipment and pressure measuring equipment and pressure measuring instruments. The wellhead was protected by a metal shed surrounded by a 6-foot high cyclone and barbed wire fence with a locked gate.

b. The exploratory R-EX or re-entry well with its wellhead valves (Christmas tree), separator and connecting piping — all configured for future gas production. One drip pan was in place around the wellhead and another was under the separator.

c. A tool and instrument shed in the vicinity of the R-EX well.

d. A large decontamination pan (old pipe rack pan).

e. Three 200-barrel water holding tanks and two 1000 gallon hydrocarbon distillate tanks, all internally contaminated. The water tanks contained a few inches of contaminated sludge solidified with bentonite. The hydrocarbon tanks were drained completely dry.

f. Telephone facilities and electric power on boards and poles.

g. The area was fenced with barbed wire and posted.

Items contaminated internally with tritium were appropriately labeled — none were externally contaminated.

6.2 Final Cleanup Effort (September 1 through October 12, 1976)

The R-E and R-EX wells were plugged and abandoned during this final cleanup period. Concurrently, the surface equipment (itemized in the preceding paragraph) was dismantled, decontaminated, documented in the release log, and removed from the site. The primary method of decontamination was by cleaning in a large sheet-steel pan using saturated steam and Steamzall (a Turco product) or detergent. The only contaminant of concern was tritium. The guideline limit for release to unrestricted use was 5,000 dpm/100 cm^2 total and 1000 dpm/100 cm^2 removable as cited in NVO-174 (Rev 1). The release log listed 126 items for unrestricted use. No item was above the ambient area background when surveyed at approximately 1 cm with an HP-210 beta-gamma probe having less than 7 mg/cm^2 absorber. Removable contamination as determined by swipe sampling was in no case more than a small fraction of the guideline.

Items having inaccessible surfaces (i.e., pipe) were initially flushed with steam and cleaning solutions until flush liquids were below detection sensitivity for tritium. Following a drying period, an appropriate amount (not to exceed 1 litre) of distilled clean water was placed in contact with the portion of the surface to be tested. A one cc aliquot of this water was collected and analyzed for tritium. If the concentration exceeded 5000 dpm/ml the item was considered unfit for unconditional release. No items decontaminated exceeded this limit.

The R-E wellhead equipment and metal shed were not contaminated and were subsequently released after the survey.

The R-EX wellhead, separator, and connecting pipeline were internally contaminated. The wellhead was disassembled so that the internal surfaces of its parts were accessible to steam cleaning. The pipeline was cut into manageable lengths which were cleaned internally with a steam lance. The separator was moved onto the decontamination pan where its pressure tanks were cut open with an acetylene torch so that internal surfaces were accessible to steam cleaning. The wellhead drip pan, the separator drip pan and the tool shed were not contaminated.

The three water holding tanks were moved onto the decontamination pan. The heater of each was removed for decontamination and to obtain a large access port to the tank. Thirty 55-gallon steel drums of solidified sludge were mucked from the bottom of these tanks through the heater openings. The heaters and the internal surfaces of the tanks were decontaminated with de-tar solvent, saturated steam, Steamzall, and detergent. The two hydrocarbon tanks had been transferred to Project Rio Blanco — they were not included in the Rulison cleanup.

7. Plugging and Abandonment Operations

The R-E and R-EX wells were plugged concurrently with the final cleanup work. The R-EX well was plugged first and the R-E well last. Both procedures required the use of a work-over drilling rig with routine support activities. Radiological monitoring support was provided to assure safety of personnel and containment of any radioactive material coming from downhole if encountered.

7.1 R-EX Well

This well was used for re-entry and production testing. It was plugged pursuant to the plan described in NVO-174 (Rev 1) without a radiological incident. An unexpected return to the surface of 300 barrels of drilling mud and water (both contaminated with low levels of tritium) was a potential contamination problem. However, this return was totally contained in tanks and was later disposed of, along with other liquids, as noted in paragraph 3.

7.2 R-E Well

This well contained stemming gravel and the device emplacement and detonation cable. There were several physical problems related to the washing out of stemming material and the removal of the cable. The original plan as outlined in NVO-174 (Rev 1) was modified by both regulatory decisions and practical exigency. During the destemming operation, the return line of the wash fluid recirculating system was continuously monitored for gamma radiation with a 2" x 2" crystal detector equipped with an alarm and recorder. A sample of the return fluid was collected at least every 120 feet of depth and analyzed for tritium by liquid scintillation. Several samples of returned stemming material were pulse height analyzed for particulate contamination. No radioactive contaminant above natural background was detected and the well was satisfactorily plugged without a radiological incident.

8. Sampling and Survey Programs

There were three sampling programs conducted. After completion of production testing in 1971, soil around the flare stack was sampled in a radial pattern. The second program was conducted in conjunction with the 1972 general cleanup. It included soil, vegetation, and water on and around the R-EX area, including more samples around the flare stack. The third program was part of the final cleanup (1976) connected with well plugging and abandonment. It included extensive soil sampling in areas of known or potential contamination based on the results of prior sampling and operating experience. This program also included sampling the creek above and below the site as well as spring water at the site.

The three sampling programs adequately delineated the extent of soil and water contamination in the site area after completion of plugging procedures on the R-E and R-EX wells. The only radioactive nuclide in the environment of the site, other than those naturally occurring or resulting from worldwide fallout, was tritium. Final survey concentration did not exceed the guideline limit of 3×10^{-2} uCi/ml (3×10^{4} pCi/ml) of soil moisture as cited in NVO-174 (Rev 1).

After the final cleanup was completed, a survey of the site was made at 1 cm distance on a 50-foot grid (10-foot grid over areas of known spills) using an HP-210 beta-gamma probe having less than 7 mg/cm^2 absorber. No reading was obtained greater than the ambient background (0.02 mrad/hr) of the area.

8.1 First Sampling Program

This program occurred in April 1971 when the site was placed in standby after completion of production tests. A total of 133 soil samples were taken at 70 sampling points around the flare stack. All samples were well below the guidelines for tritium in soil moisture. Figures 4 and 5 show the location of each sampling point by azimuth and distance from the flare stack, and the tritium concentration in soil moisture per milliliter and per gram at the indicated sample depths. Table 1 provides the same information in tabular form.

8.2 Second Sampling Program

This program was part of the general cleanup conducted in July 1972. It included the sampling of soil, vegetation and water.

8.2.1 Soil Sampling

A square grid of soil sampling points was laid out on magnetic cardinal headings using the site entrance gate post as the zero and primary reference point. Ten and twenty foot squares were used, depending on the area use history and on the probability of soil contamination. Further, squares were sometimes distorted to sample points of special interest such as storage tanks, pipeline runs, the separator, and drip pan areas or to avoid obstructions such as cement pads. While the flare stack was located on the square grid system, the area around it was sampled on a radial grid referenced to the stack. This radial grid was used because contaminated fallout originated from the stack as a center and because a radial sampling grid was used previously during postflare operations, making a comparison more meaningful. A total of 192 sampling points was located (see Figures 6 and 7). Most of these points were sampled at 1 and 12 inch depths. Fourteen points were sampled at 1, 12, 24 and 48 inch depths. Two points were sampled at multiple depths to 96 and 132 inches respectively. A few were sampled at other selected depths for various reasons. A total of 426 soil samples was collected for tritium analysis.

The depth increment for soil samples taken was 1 inch (i.e., the 1 inch sample was from the surface to 1 inch, the 12 inch sample was from 11 to 12 inches, etc.). Soil samples were collected in standard 16 ounce cottage cheese containers that held 24 to 27 cubic inches of sample. Therefore, with a depth increment of 1 inch, the sampled soil area for each sample was from 4.9 to 5.2 inches square. At undisturbed and uncompacted sampling locations, an earth auger was used to bore holes up to 4 feet deep. For sampling at greater depths, and at disturbed and compacted locations, a powered backhoe was used to dig required holes. After these holes were cleaned out, the samples were taken from their side walls at measured depths. Access to sampling points under waste water storage tanks was attained by drilling horizontally under each tank from a trench at its perimeter. Access to sampling points under drip pans was attained by cutting through the pan or by moving it to one side.

Each sample was weighed wet, as collected, and was then dried in an electric oven for 15 hours at 180 degrees centigrade. After drying the sample was again weighed. Wet and dry weights were recorded for each sample and the percentages of moisture were calculated. Where possible, a 5 ml aliquot of soil moisture was distilled from each sample. The aliquots were analyzed by liquid scintillation for tritium concentration in pCi/ml. From this, the concentration in pCi/g was calculated. Results of these analyses are shown in Table 2.

No soil exceeded the tritium concentration criterion of 3×10^4 pCi/g; therefore, none was removed from the area.

Eight randomly located soil samples were collected for pulse heights analysis by gamma spectrometry. No radioisotopes other than those naturally occurring were detected.

8.2.2 Vegetation Sampling

A vegetation sample was taken at each cardinal point on a 500 foot and a 1000 foot arc around the flare stack. Additional vegetation samples were collected at side grid point N-14, W-2 and stack grid points 030°, 5' and 120°, 40'. These samples were collected because of a leak from a water storage tank, the close proximity to the flare stack, and the area of highest concentration indicated by the post-flare sampling, respectively.

Vegetation samples were analyzed at EIC's facilities in Albuquerque after the cleanup operation. Each sample was weighed wet and dry. An aliquot of moisture was distilled from the sample. An aliquot of dry sample was oxidized and condensed to obtain the bound tritium. The results of these analyses are shown in Table 3.

8.2.3 Water Sampling

Prior to completion of the cleanup, water samples were taken from each of two local springs at the site. One was located just off the southeast corner of the R-EX well pad, the other was on the upper side of the road about 300 yards downhill from the pad. Both samples were analyzed by liquid scintillation. No tritium was detected.

8.3 Third Sampling Program

This program, the final cleanup (September 1 – October 12, 1976), was associated with the plugging of wells and abandonment of the Rulison site. It was designed to consider the history of the site and then to complete all requirements of ERDA Appendix 5301 for radiation contamination clearance. It considered primarily of sampling soil:

a. at two locations that in the 1972 general cleanup, exceeded the current guideline for tritium;

b. at the location of a known spill during the final cleanup (1976);

c. in the vicinity of decontamination work; and

d. around the R-E wellhead location.

In addition, the creek was sampled above and below the site, and the same two springs (one on the site, one about 300 yards down the road) were sampled.

8.3.1 Sampling Point N-14.2, E-.7 (see Figure 7 for the location of this point).

In July 1972, the samples taken at 24 and 36 inch depths contained a concentration of 35,000 and 34,000, respectively, pCi/ml tritium in soil moisture. The guideline in NVO-174 (Rev 1) was 30,000 pCi/ml. This contamination was the result of a known spill from a valve that froze and broke during the 1971-1972 winter. This sampling point and the area adjacent to the spill were sampled thoroughly. Results of analyses showed that intervening time and weather had reduced contamination to negligible levels. The sample locations and results of analyses are shown on Fig Figure 8 and in Table 4.

8.3.2 Sampling Point S-24.6, E-13.7 (see Figure 6 for the location of this point).

In July 1972, the surface sample taken here contained 47,000 pCi/ml tritium in soil moisture. This was the result of a spill that occurred during production test operations. This point and the adjacent area, including the separator location, were sampled. Results of analyses showed that soil contamination at this location is now negligible. The sample locations and results of analyses are shown on Figure 9 and in Table 5.

8.3.3 Accidental Spill Area

On September 1, 1976 the separator was being moved onto the decontamination pan. It was dropped about half on and half off the pan. Liquid spilled from the separator to the pan and to the soil southwest of the pan. An estimated 60 gallons spilled on the soil. The tritium concentration in the separator liquid was about 230,000 pCi/ml.

Soil visually moistened by the liquid was picked up, mixed with diatomaceous earth for additional drying, and was contained in plastic-lined 55-gallon steel drums. Preliminary samples were taken and more soil where indicated was picked up. Figure 10A shows a sketch of the spill area after 15 drums of soil were removed.

On September 16, 1976, the area was divided into a 5 foot grid locating 42 sampling points, and a surface sample was taken at each point. Figure 10B shows that the contaminated area was delineated and that the decontamination effort had been very effective. All points sampled were less than the guideline — the highest concentration detected was 13,078 pCi/ml tritium in soil moisture.

On September 21, 1976, five more drums of soil were removed from the area of highest concentration as indicated by the contour boundary line on Figure 10C. Samples were taken the length and direction of the removed soil as shown also on Figure 10C.

On September 23, 1976, a transect of sampling holes was dug as shown on Figure 10D to determine a vertical profile of concentrations across the spill area. Results of these samples are indicated on the figure.

On October 1, 1976, a final comprehensive sampling of the spill area was made. Three ditches were dug with a backhoe across the area of interest to a depth of 60 inches. The side walls of each ditch were sampled at four locations at depths of 12, 24, 36, 48 and 60 inches. Figure 10E shows the locations and results of these samples. Table 6 tabulates the same results. The Figure and Table show that the spill area had been successfully decontaminated.

8.3.4 Decontamination Work Area

This included the area around and under the decontamination pan and the adjacent area used to convert low level tritiated water into steam for disposal. After work in the area was completed, the soil was sampled at 25 sampling points on the surface and at 12 inches depth, a total of 50 samples. Results of sample analyses and the locations are shown on Figure 11. The results are also tabulated on Table 7. Note that all concentration of tritium in soil moisture was negligible except for two locations where the highest of four samples was 10,953 pCi/ml, still well below the guideline. This anomaly can be explained by the fact that a small hole was punched through the pan at that location. A small amount of the decontaminating liquid leaked to the soil before the hole could be repaired.

8.3.5 R-E Wellhead Area

No contamination had ever been detected in the recirculating fluid during the destemming operation, nor were the wellhead or workover rig contaminated, therefore, there was little or no potential for soil contamination around the wellhead. However, since this area had not been previously sampled, soil samples were taken from the surface and from 12 inch depth at the four corners one foot from the cement cellar — a total of eight samples. Locations and analytical results are shown on Figure 12, and the results are tabulated in Table 8. Concentrations of tritium in soil moisture were negligible, as expected.

8.3.6 Surface Water

Surface water was sampled at the four locations mentioned: the creek above and below the site, the spring on the site, and the spring down the road from the site. Tritium was not detected at a detection sensitivity of 2 pCi/ml.

9. Conclusion

A review of 1) the history of operations at the Rulison site, 2) the analytical results of sampling programs, 3) and the results of a current detailed radiological survey, identified the extent of radioactive contamination of the property. The only nuclide of concern was tritium in surface soil moisture. A reasonable and conscientious effort was made to reduce contamination to an amount as low as practicable considering the factors of health and economics. Concentrations of the contaminant, where detected, were in most cases negligible and in no case greater than a fraction of the guideline. There is nothing to prevent the Rulison site from being returned to unrestricted use, subject to applicable subsurface drilling restrictions as stated in Project Rulison Well Plugging and Site Abandonment Plan NVO-174 (REV-1) and Project Rulison Well Plugging and Site Abandonment Final Report NVO-187.

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TABLE 1

(Page 1 of 4)

TRITIUM IN RULISON SOIL MOISTURE

POSTPRODUCTION TEST – APRIL 23, 1971

Grid Coordinate (1)	Sampling Depth (in.) (4)	pCi/ml (2)	pCi/g (soil) (3)
000°, 20'	1	390	100
000°, 20'	3	980	250
000°, 20'	6	480	120
000°, 20'	0 to 2	940	250
000°, 20'	2 to 4	540	130
000°, 20'	4 to 6	260	68
000°, 20'	6 to 8	220	55
000°, 20'	8 to 10	260	62
000°, 20'	10 to 12	210	50
000°, 40'	1	1,700	420
000°, 40'	0 to 2	400	94
000°, 40'	2 to 4	510	120
000°, 40'	4 to 6	750	180
000°, 40'	6 to 8	660	150
000°, 40'	8 to 10	580	130
000°, 40'	10 to 12	510	110
000°, 80'	1	180	44
000°, 80'	0 to 2	350	88
000°, 80'	2 to 4	510	110
000°, 80'	4 to 6	500	100
000°, 80'	6 to 8	370	88
000°, 80'	8 to 10	280	57
000°, 80'	10 to 12	210	46
000°, 120'	1	650	230
000°, 120'	0 to 2	410	110
000°, 120'	2 to 4	340	71
000°, 120'	4 to 6	290	68
000°, 120'	6 to 8	320	76
000°, 120'	8 to 10	250	62
000°, 120'	10 to 12	210	49
000°, 200'	1	130	43
000°, 500'	1	39	9.8
000°, 500'	6	20	3.4
000°, 1000'	1	19	4.1

(1) Radial coordinates are in degrees and feet referenced to flare stack.

(2) Concentrations are rounded to two significant figures.

(3) Idem.

(4) Sampling depth increments, when not otherwise indicated, are 1". (i.e., 1" is from 0 to 1", 6" is from 5" to 6", etc.)

TABLE 1

(Page 2 of 4)

TRITIUM IN RULISON SOIL MOISTURE

POSTPRODUCTION TEST – APRIL 23, 1971

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
000°, 1000′	6	12	2.7
030°, 20′	1	510	130
030°, 40′	1	140	34
030°, 200′	1	79	18
030°, 80′	1	97	23
030°, 120′	1	180	42
060°, 20′	1	760	210
060°, 40′	1	300	80
060°, 80′	1	120	20
060°, 120′	1	300	120
060°, 200′	1	70	24
090°, 20′	1	300	76
090°, 40′	1	160	44
090°, 80′	1	130	36
090°, 120′	1	260	82
090°, 200′	1	46	16
090°, 500′	1	2,400	630
090°, 500′	6	53	14
090°, 1000′	1	11	3.2
090°, 1000′	6	13	3.3
120°, 20′	1	3,800	970
120°, 40′	1	2,100	550
120°, 80′	1	1,400	370
120°, 120′	1	190	56
120°, 200′	1	380	55
150°, 20′	1	130	29
150°, 40′	1	710	160
150°, 80′	1	200	54
150°, 120′	0 to 1	210	65
150°, 120′	1 to 2	180	53
150°, 120′	2 to 4	220	62
150°, 120′	4 to 8	290	87
150°, 120′	8 to 12	420	110
150°, 120′	12 to 16	340	84
150°, 120′	16 to 20	130	25
150°, 120′	20 to 24	79	16
150°, 120′	24 to 28	75	15
150°, 120′	28 to 32	110	19
150°, 120′	32 to 36	110	22
150°, 120′	36 to 40	87	19
150°, 120′	40 to 44	62	14
150°, 120′	44 to 48	59	13
150°, 200′	1	190	34
180°, 5′	1	7,400	1,600
180°, 5′	6	3,000	700

TABLE 1

(Page 3 of 4)

TRITIUM IN RULISON SOIL MOISTURE

POSTPRODUCTION TEST – APRIL 23, 1971

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
180°, 20′	1	2,800	620
180°, 40′	1	170	33
180°, 80′	1	410	85
180°, 120′	1	1,500	300
180°, 200′	1	79	8.7
180°, 500′	1	1,900	650
180°, 500′	6	6	1.1
180°, 1000′	1	57	14
180°, 1000′	6	6	1.2
210°, 20′	1	540	130
210°, 40′	1	240	50
210°, 80′	1	110	33
210°, 120′	1	100	23
210°, 200′	1	84	10
240°, 14′	1	2,800	730
240°, 20′	1	680	180
240°, 40′	1	270	62
240°, 80′	1	130	28
240°, 120′	1	34	7
240°, 200′	1	77	8.1
270°, 20′	1	1,600	410
270°, 40′	1	240	68
270°, 80′	1	240	60
270°, 120′	1	230	53
270°, 200′	1	37	10
270°, 500′	1	8	1.2
270°, 500′	6	26	5.8
270°, 1000′	1	12	2.6
270°, 1000′	6	27	5.6
300°, 20′	1	1,200	310
300°, 40′	1	200	54
300°, 80′	1	340	76
300°, 120′	1	88	21
300°, 200′	1	140	32
330°, 20′	1	1,900	500
330°, 20′	3	5,700	1,400
330°, 20′	6	6,800	1,600
330°, 20′	1	1,400	350
330°, 20′	2	790	200
330°, 20′	2 to 4	1,900	480
330°, 20′	4 to 8	4,500	1,100
330°, 20′	8 to 12	3,800	900
330°, 20′	12 to 16	3,100	710
330°, 20′	16 to 24	1,900	440

TABLE 1

(Page 4 of 4)

TRITIUM IN RULISON SOIL MOISTURE

POSTPRODUCTION TEST — APRIL 23, 1971

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
330°, 20'	24 to 28	860	200
330°, 20'	28 to 32	190	43
330°, 20'	32 to 36	250	57
330°, 20'	36 to 40	40	8.1
330°, 20'	40 to 44	280	60
330°, 20'	44 to 48	250	47
330°, 40'	1	160	44
330°, 80'	1	230	56
330°, 120'	1	270	76
330°, 200'	1	210	60

TABLE 2

(Page 1 of 9)

TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate (1)	Sampling Depth (in.) (2)	pCi/ml (3)	pCi/g (soil) (4)
N-0, E-2	1	14	0.01
N-0, E-2	12	(5) ND	ND
N-1, E-2	1	3.2	0.007
N-1, E-2	12	14	5.2
N-2, E-2	1	ND	ND
N-2, E-2	12	13	2.9
N-3, E-.7	1	ND	ND
N-3, E-.7	12	5.2	1.1
N-3, E-2	1	ND	ND
N-3, E-2	12	ND	ND
N-4, E-.7	1	3.8	0.4
N-4, E-.27	12	ND	ND
N-4, E-2	1	ND	ND
N-4, E-2	12	ND	ND
N-5, E-.7	1	4.3	0.5
N-5, E-.7	12	4.9	0.95
N-5, E-2	1	ND	ND
N-5, E-2	12	ND	ND
N-6, E-.7	1	ND	ND
N-6, E-2	1	290	23
N-6, E-2	12	4.0	0.8
N-7, E-.7	1	ND	ND
N-7, E-.7	12	5.9	2.0
N-7, E-2	1	3.9	0.1
N-7, E-2	12	8.3	1.8
N-8, E-.7	1	ND	ND
N-8, E-.7	12	ND	ND
N-8, E-2	1	ND	ND
N-8, E-2	12	ND	ND
N-9, E-.7	1	ND	ND
N-9, E-.7	12	ND	ND
N-9, E-2	1	33	5.8
N-9, E-2	12	4.2	0.9
N-10, E-.7	1	6.1	0.68
N-10, E-.7	12	ND	ND
N-10, E-2	1	2.8	0.08
N-10, E-2	12	100	24
N-11, E-2	1	190	2.8
N-11, E-2	12	4.1	0.9
N-11.2, E-.2	1	310	25
N-11.2, E-.2	12	38	6.0

(1) Cardinal coordinates referenced to entrance gate post scale; 1 unit equals 10 feet. Radial coordinates are in degrees and feet referenced to flare stack.

(2) Sampling depth increments are 1" (i.e., 1" is from 0 to 1", 12" is from 11" to 12", etc.)

(3) Concentrations are rounded to two significant figures.

TABLE 2

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TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
N-11.4, E-0	6	2,400	1,300
N-11.8, E-0	24	850	510
N-11.8, E-0	60	7,800	4,400
N-11.9, E-2.8	1	11	2.3
N-11.9, E-2.8	12	33	6.9
N-11.9, E-3.3	1	110	24
N-11.9, E-3.3	12	93	22
N-12, E-.7	1	600	62
N-12, E-.7	12	920	320
N-12, E-2	1	21	1.0
N-12, E-2	12	ND	ND
N-12.5, E-0	1	300	34
N-12.5, E-0	12	120	15
N-12.7, E-0	6	150	81
N-12.7, E-2.8	1	44	10
N-12.7, E-2.8	12	ND	ND
N-12.7, E-3.3	1	21	8.3
N-12.7, E-3.3	12	11	4.7
N-13, E-0	12	73	41
N-13, E-0	60	51	24
N-13, E-.7	1	87	9.3
N-13, E-.7	12	200	49
N-13, E-2	1	51	2.4
N-13, E-2	12	2.9	0.6
N-13, W-3	1	57	27
N-13, W-3	12	13	6.2
N-13.7, E-.1	1	10,000	1,400
N-13.7, E-.1	12	20,000	5,600
N-13.7, E-.1	24	21,000	5,800
N-13.7, E-.6	1	2,700	150
N-13.7, E-.6	12	5,100	1,600
N-13.7, E-.6	24	4,700	1,400
N-14, E-0	1	4,700	1,400
N-14, E-0	12	3,300	1,800
N-14, E-2	1	22	0.3
N-14, E-2	12	3.3	0.7
N-14.2, E-.7	1	8,600	1,500
N-14.2, E-.7	12	29,000	6,500
N-14.2, E-.7	24	35,000	11,000
N-14.2, E-.7	36	34,000	19,000
N-14.2, E-.7	48	27,000	7,300
N-14.2, E-.7	60	26,000	14,000
N-14.2, E-.7	72	18,000	9,600
N-14.2, E-.7	96	8,000	4,500
N-14.2, E-.7	108	9,700	2,300
N-14.2, E-.7	120	5,600	1,400
N-14.2, E-.7	132	3,300	600
N-14, W-2	1	110	49
N-14, W-2	12	51	7.7

TABLE 2

TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
N-14, W-4	1	16	7.3
N-14, W-4	12	4.4	2.1
N-14.2, E-0	6	3,100	1,700
N-15, E-1	1	650	290
N-15, E-1	12	1,400	670
N-15, E-2	1	300	140
N-15, E-2	12	11	6.0
N-15, W-3	1	420	22
N-15, W-3	12	130	16
N-16, E-1	1	270	120
N-16, E-1	12	260	140
N-16, E-2	1	26	11
N-16, E-2	12	5.3	2.6
N-17, E-1	1	160	75
N-17, E-1	12	17,000	6,000
N-16.7, E-2	1	36	0.9
N-16.7, E-2	12	ND	ND
N-17.8, E-2	1	710	370
N-17.8, E-2	12	330	170
N-18, E-1	1	11	5.3
N-18, E-1	12	80	41
N-19, E-1	1	25	12
N-19, E-1	12	22	11
N-19, E-2	1	10	4.5
N-19, E-2	12	15	7.1
N-20, E-1	1	8.4	3.9
N-20, E-1	12	280	130
N-20, E-2	1	71	34
N-20, E-2	12	10	4.6
N-21, E-1	1	44	20
N-21, E-1	12	73	30
N-21, E-2	1	56	25
N-21, E-2	12	ND	ND
N-22, E-1	1	25	12
N-22, E-1	12	100	43
N-22, E-2	1	8.4	3.9
N-22, E-2	12	23	12
N-23, E-1	1	15	6.8
N-23, E-1	12	290	140
N-23, E-2	1	6.6	3.2
N-23, E-2	12	3.4	1.7
N-24, E-1	1	59	26
N-24, E-1	12	69	33
N-24, E-2	1	450	220
N-24, E-2	12	6.9	3.6
N-24, W-2	72	14	2.1
N-25, E-1	1	16	7.1
N-25, E-1	12	15	7.3
N-25, E-2	1	18	8.7
N-25, E-2	12	22	11

TABLE 2

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TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
N-26, E-1	1	15	6.4
N-26, E-1	12	39	19
N-26, E-2	1	31	14
N-26, E-2	12	34	17
N-27, E-1	1	44	23
N-27, E-1	12	51	24
N-28, E-1	1	390	180
N-28, E-1	12	160	86
000°, 20′	1	180	44
000°, 20′	12	290	94
000°, 40′	1	43	3.2
000°, 40′	12	14	1.1
030°, 20′	1	32	8.5
030°, 20′	12	53	18
030°, 40′	1	22	1.1
030°, 40′	12	ND	ND
060°, 20′	1	10	3.5
060°, 20′	12	14	4.3
060°, 40′	1	100	12
060°, 40′	12	11	0.75
090°, 20′	1	84	4.9
090°, 20′	12	27	8.6
090°, 40′	1	32	3.0
090°, 40′	12	4.8	0.55
120°, 20′	1	74	7.3
120°, 20′	12	45	6.0
120°, 20′	24	290	40
120°, 20′	48	81	42
120°, 40′	1	18	2.0
120°, 40′	12	15	1.4
120°, 40′	24	140	28
120°, 40′	48	380	73
120°, 60′	1	60	8.4
120°, 60′	12	27	3.6
120°, 60′	24	290	160
120°, 60′	48	290	61
150°, 20′	1	28	2.3
150°, 20′	12	3.6	0.6
150°, 40′	1	37	5.4
150°, 40′	12	21	3.1
210°, 20′	1	170	7.1
210°, 20′	12	220	48
210°, 40′	1	11	0.46
210°, 40′	12	ND	ND
240°, 20′	1	1,100	82
240°, 20′	12	4,700	1,400
240°, 40′	1	60	7.6
240°, 40′	12	16	2.0

TABLE 2

(Page 5 or 9)

TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
270°, 20′	1	16	5.3
270°, 20′	12	53	17
270°, 40′	1	22	0.93
270°, 40′	12	ND	ND
300°, 3′	1	230	100
300°, 3′	12	780	400
300°, 3′	24	3,300	1,900
300°, 3′	36	3,800	820
300°, 3′	48	5,700	1,300
300°, 3′	60	6.400	3,200
300°, 3′	72	4,400	2,500
300°, 3′	84	2,900	1,400
300°, 3′	96	2,700	1,300
300°, 20′	1	400	115
300°, 20′	12	450	150
300°, 20′	24	3,900	520
300°, 20′	48	2,500	520
300°, 40′	1	42	2.1
300°, 40′	12	8.6	1.2
330°, 20′	1	350	100
330°, 20′	12	600	180
330°, 40′	1	65	4.1
330°, 40′	12	17	1.5
S-1, E-1	1	6.5	0.04
S-1, E-1	12	ND	ND
S-1, E-2	1	10	0.006
S-1, E-2	12	ND	ND
S-1, E-3	1	ND	ND
S-1, E-3	12	ND	ND
S-2, W-.7	1	ND	ND
S-2, W-.7	12	7.3	1.2
S-3, E-0	1	1,500	810
S-3, E-0	12	66	11
S-3, E-2	1	ND	ND
S-3, E-2	12	ND	ND
S-3.8, E-1.4	1	ND	ND
S-3.8, E-1.4	12	ND	ND
S-5, E-0	1	ND	ND
S-5, E-0	12	ND	ND
S-5, E-2	1	ND	ND
S-5, E-2	12	ND	ND
S-5, E-4	1	ND	ND
S-5, E-4	12	20	3.4
S-5.7, W-2	1	200	7.5
S-5.7, W-2	12	2.9	0.56
S-7, E-0	1	ND	ND
S-7, E-0	12	ND	ND
S-7, E-2	1	ND	ND
S-7, E-2	12	ND	ND

TABLE 2

(Page 6 of 9)

TRITIUM IN RULISON SOIL MOISTURE — JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
S-7, E-4	1	ND	ND
S-7, E-4	12	ND	ND
S-7, E-6	1	70	29
S-7, E-6	12	ND	ND
S-7, E-8	1	770	13
S-7, E-8	12	ND	ND
S-7, E-10	1	91	2.3
S-7, E-10	12	ND	ND
S-7, E-12	1	6.7	0.17
S-7, E-12	12	ND	ND
S-7.5, W-2.7	1	43	0.37
S-7.5, W-2.7	12	ND	ND
S-8, W-1.5	1	ND	ND
S-8, W-1.5	12	ND	ND
S-9, E-0	1	ND	ND
S-9, E-0	12	ND	ND
S-9, E-2	1	100	41
S-9, E-2	12	ND	ND
S-9, E-4	1	ND	ND
S-9, E-4	12	ND	ND
S-9, E-6	1	ND	ND
S-9, E-6	12	ND	ND
S-9, E-8	1	ND	ND
S-9, E-8	12	ND	ND
S-9, E-10	1	130	4.5
S-9, E-10	12	ND	ND
S-9, E-12	1	110	2.1
S-9, E-12	12	ND	ND
S-9.4, W-3.4	1	3,900	32
S-9.4, W-3.4	12	230	25
S-10, W-1.5	1	ND	ND
S-10, W-1.5	12	ND	ND
S-10.3, E-10.1	1	ND	ND
S-10.3, E-10.1	12	ND	ND
S-10.3, E-10.1	24	ND	ND
S-10.3, E-10.1	48	ND	ND
S-11, E-0	1	610	11
S-11, E-0	12	ND	ND
S-11, E-2	1	ND	ND
S-11, E-2	12	ND	ND
S-11, E-4	1	62	0.98
S-11, E-4	12	ND	ND
S-11, E-6	1	ND	ND
S-11, E-6	12	ND	ND
S-11, E-8	1	ND	ND
S-11, E-8	12	ND	ND
S-11, E-10	1	ND	ND
S-11, E-10	12	ND	ND
S-11, E-12	1	ND	ND
S-11, E-12	12	ND	ND

TABLE 2
(Page 7 of 9)
TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
S-11, E-14	1	ND	ND
S-11, E-14	12	ND	ND
S-11.2, W-4	1	280	21
S-11.2, W-4	12	ND	ND
S-11.7, E-3.1	1	ND	ND
S-11.7, E-3.1	12	ND	ND
S-11.7, E-8.7	1	ND	ND
S-11.7, E-8.7	12	ND	ND
S-11.7, E-8.7	24	ND	ND
S-11.7, E-8.7	48	ND	ND
S-12, E-1	1	ND	ND
S-12, E-1	12	ND	ND
S-12, E-5	1	18	0.2
S-12, E-5	12	ND	ND
S-12, W-1.5	1	3.8	0.2
S-12, W-1.5	12	ND	ND
S-12.4, E-3.8	1	ND	ND
S-12.4, E-3.8	12	ND	ND
S-12.8, E-1.9	1	ND	ND
S-12.8, E-1.9	12	ND	ND
S-12.8, E-1.9	24	ND	ND
S-12.8, E-1.9	48	ND	ND
S-13, E-0	1	ND	ND
S-13, E-0	12	ND	ND
S-13, E-6	1	ND	ND
S-13, E-6	12	ND	ND
S-13, E-8	1	14	0.32
S-13, E-8	12	84	6.3
S-13, E-10	1	1	0.01
S-13, E-10	12	ND	ND
S-13, E-12	1	ND	ND
S-13, E-12	12	ND	ND
S-13, E-14	1	ND	ND
S-13, E-14	12	ND	ND
S-13.1, E-7.3	1	ND	ND
S-13.1, E-7.3	12	ND	ND
S-13.1, E-7.3	24	ND	ND
S-13.1, E-7.3	48	ND	ND
S-13.1, W-4.8	1	690	290
S-13.1, W-4.8	12	ND	ND
S-13.2, E-4.5	1	ND	ND
S-13.2, E-4.5	12	ND	ND
S-13.5, E-2.8	1	ND	ND
S-13.5, E-2.8	12	ND	ND
S-13.9, E-5.2	1	ND	ND
S-13.9, E-5.2	12	ND	ND
S-14, E-.8	1	ND	ND
S-14, E-.8	12	ND	ND
S-14, W-3.4	1	120	1.1
S-14, W-3.4	12	45	8.5

TABLE 2

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TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
S-14.2, E-3.4	1	ND	ND
S-14.2, E-3.4	12	12	1.6
S-14.2, E-3.4	24	ND	ND
S-14.2, E-3.4	48	ND	ND
S-14.6, E-5.9	1	20	0.1
S-14.6, E-5.9	12	ND	ND
S-14.6, E-5.9	24	ND	ND
S-14.6, E-5.9	48	ND	ND
S-14.7, E-1.6	1	ND	ND
S-14.7, E-1.6	12	ND	ND
S-15, E-12	1	26	0.03
S-15, E-12	12	ND	ND
S-15, E-14	1	ND	ND
S-15, E-14	12	ND	ND
S-15, W-1.8	1	76	1.4
S-15, W-1.8	12	1,400	210
S-15.4, E-2.2	1	ND	ND
S-15.4, E-2.2	12	ND	ND
S-15.4, E-5	1	55	0.4
S-15.4, E-5	12	ND	ND
S-15.4, E-5	24	ND	ND
S-15.4, E-5	48	ND	ND
S-15.4, E-6.6	1	480	7.6
S-15.4, E-6.6	12	ND	ND
S-15.4, E-8	1	ND	ND
S-15.4, E-8	12	12	2.1
S-16, E-0	1	ND	ND
S-16, E-0	12	ND	ND
S-16.1, E-3	1	520	16
S-16.1, E-3	12	ND	ND
S-16.2, E-4	1	48	1.3
S-16.2, E-4	12	ND	ND
S-16.2, E-4	24	ND	ND
S-16.2, E-4	48	ND	ND
S-16.6, E-6.6	1	8.5	0.2
S-16.6, E-6.6	12	5.3	0.5
S-16.6, E-6.6	24	8.9	0.9
S-16.6, E-6.6	48	ND	ND
S-16.6, E-8	1	5.9	0.24
S-16.6, E-8	12	5.7	0.3
S-17, E-10	1	ND	ND
S-17, E-10	12	ND	ND
S-17, E-12	1	ND	ND
S-17, E-12	12	46	2.4
S-17, E-14	1	190	54
S-17, E-14	12	ND	ND
S-17.1, E-1.8	1	89	1.2
S-17.1, E-1.8	12	ND	ND
S-18, E-6.5	1	11	0.1
S-18, E-6.5	12	14	1.3

TABLE 2

(Page 9 of 9)

TRITIUM IN RULISON SOIL MOISTURE – JULY 1972

Grid Coordinate	Sampling Depth (in.)	pCi/ml	pCi/g (soil)
S-18.2, E-3.5	1	270	56
S-18.2, E-3.5	12	ND	ND
S-19, E-8	1	11	0.67
S-19, E-8	12	ND	ND
S-19, E-9	1	ND	ND
S-19, E-9	12	ND	ND
S-19, E-9	24	ND	ND
S-19, E-9	48	ND	ND
S-19, E-10	1	ND	ND
S-19, E-10	12	50	4.9
S-19, E-12	1	ND	ND
S-19, E-12	12	5.8	0.28
S-19, E-14	1	ND	ND
S-19, E-14	12	ND	ND
S-19.3, E-5.1	1	58	1.4
S-19.3, E-5.1	12	11	2.3
S-20, E-12	1	12	0.56
S-20, E-12	12	15	0.39
S-20.4, E-6.8	1	ND	ND
S-20.4, E-6.8	12	ND	ND
S-21, E-14	1	19	0.43
S-21, E-14	12	ND	ND
S-21.5, E-8.5	1	300	2.2
S-21.5, E-8.5	12	ND	ND
S-22.5, E-10.2	1	130	0.52
S-22.5, E-10.2	12	ND	ND
S-23.2, E-17	1	9.4	4.1
S-23.2, E-17	12	ND	ND
S-23.5, E-12	1	13	0.54
S-23.5, E-12	12	4.1	0.71
S-23.5, E-12	1	32	1.2
S-23.8, E-15.3	12	ND	ND
S-24.6, E-13.7	1	47,000	20,000
S-24.6, E-13.7	12	860	140
S-24.6, E-17	1	36	0.39
S-24.6, E-17	12	19	3.2
S-25.4, E-15.4	1	1,400	22
S-25.4, E-15.4	12	1,700	235

TABLE 3

TRITIUM IN VEGETATION – JULY 1972

Sampling Point (referenced to flare stack)	Dry/Wet Ratio	Unbound [1] pCi/ml (H_2O)	Unbound [1] pCi/g (wet)	Bound [2] pCi/ml (H_2O) (water from oxidation)	Bound [2] pCi/g (wet)	Total pCi/g (wet)
000°, 500′	0.38	7.0	4.3	< 31	<1.7	≈ 4.3
000°, 1000′	0.42	7.2	2.8	< 8.3	<1.4	≈ 2.8
090°, 500′	0.23	4.5	3.5	< 32	<1.5	≈ 3.5
090°, 1000′	0.30	8.1	5.7	< 33	<1.1	≈ 5.7
180°, 500′	0.22	75	58	< 16	<0.9	≈ 58
180°, 1000′	0.25	7.1	5.3	< 11	<0.8	≈ 5.3
270°, 500′	0.19	5.5	4.5	< 28	<0.8	≈ 4.5
270°, 1000′	0.25	7.5	5.6	< 14	<1.0	≈ 5.6
030°, 5′	0.13	170	150	190	5.3	160
120°, 40′	0.27	64	47	97	3.6	51
*N-14, W-2	0.22	150	120	41	2.3	120

*West of tank 3, referenced to entrance gate post.

(1) Unbound; tritium in water that was removable by drying the sample in an electric oven for 16 hours.

(2) Bound; tritium converted to water form by oxidizing the dried sample.

TABLE 4

TRITIUM IN SOIL AT SAMPLING POINT N-14.2, E-.7 – OCTOBER 1976

Sample Identification	Sampling Depth (in.)	pCi/ml in Soil Moisture
Location A	Surface	15
Location B	Surface	795
Location C	Surface	9
Location D	Surface	9
Location E	Surface	18
Location F	Surface	71
Location G	Surface	267
Location H	Surface	48
N-14.2, E-.7	Surface	ND
N-14.2, E-.7	24	ND
N-14.2, E-.7	36	19
N-14.2, E-.7	48	20
Trench, South End	36	65
Trench, South End	48	91
Trench, South End	60	112
Trench, Mid-Point	36	159
Trench, Mid-Point	48	160
Trench, Mid-Point	60	44
Trench, North End	36	70
Trench, North End	48	60
Trench, North End	60	63

TABLE 5

TRITIUM IN SOIL AT SAMPLING POINT S-24.6, E-13.7 – OCTOBER 1976

Sample Identification	Sampling Depth (in.)	pCi/ml in Soil Moisture
Location A	Surface	11
Location B	Surface	8
Location C	Surface	6
Location D	Surface	ND
Location E	Surface	ND
Location F	Surface	359
Location G	Surface	4
Location H	Surface	19
Location I	Surface	55
Location J	Surface	24
Location K	Surface	20
Location L	Surface	50
S-24.6, E-13.7	1	ND
S-24.6, E-13.7	12	32
S-24.6, E-13.7	24	52
S-24.5, E-13.7	36	134
S-24.6, E-13.7 (NE 4′)	Surface	ND
S-24.6, E-13.7 (SE 4″)	Surface	ND
S-24.6, E-13.7 (SW 4′)	Surface	ND
S-24.6, E-13.7 (NW 4′)	Surface	ND
Trench Wall, East End	36	ND
Trench Wall, East End	48	ND
Trench Wall, East End	60	ND
Trench Wall, Center	36	ND
Trench Wall, Center	48	28
Trench Wall, Center	60	ND
Trench Wall, West End	36	ND
Trench Wall, West End	48	ND
Trench Wall, West End	60	ND

TABLE 6

(Page 1 of 2)

TRITIUM IN SOIL AT SPILL AREA AFTER DECONTAMINATION — OCTOBER 1976

Sample Identification	Sampling Depth (in.)	pCi/ml in Soil Moisture
South Trench #1, East Wall	12	ND
South Trench #1, East Wall	24	ND
South Trench #1, East Wall	36	ND
South Trench #1, East Wall	48	ND
South Trench #1, East Wall	60	ND
South Trench #1, S. E. Wall	12	ND
South Trench #1, S. E. Wall	24	ND
South Trench #1, S. E. Wall	36	116
South Trench #1, S. E. Wall	48	124
South Trench #1, S. E. Wall	60	ND
South Trench #1, S. Drain Area	24	1401
South Trench #1, S. W. Wall	12	ND
South Trench #1, S. W. Wall	24	ND
South Trench #1, S. W. Wall	36	ND
South Trench #1, S. W. Wall	48	ND
South Trench #1, S. W. Wall	60	ND
South Trench #1, West Wall	12	48
South Trench #1, West Wall	24	9
South Trench #1, West Wall	36	24
South Trench #1, West Wall	48	10
South Trench #1, West Wall	60	37
Mid Trench #2, East Wall	12	ND
Mid Trench #2, East Wall	24	ND
Mid Trench #2, East Wall	36	ND
Mid Trench #2, East Wall	48	ND
Mid Trench #2, East Wall	60	ND
Mid Trench #2, Center	12	38
Mid Trench #2, Center	24	21
Mid Trench #2, Center	36	9
Mid Trench #2, Center	48	ND
Mid Trench #2, Center	60	ND
Mid Trench #2, West Wall	12	610
Mid Trench #2, West Wall	24	1175
Mid Trench #2, West Wall	36	1288
Mid Trench #2, West Wall	48	1171
Mid Trench #2, West Wall	60	10
Mid Trench #2, West End	Surface	18
Mid Trench #2, West End	12	298
Mid Trench #2, West End	24	454
Mid Trench #2, West End	36	282
Mid Trench #2, West End	48	352
North Trench #3, East Wall	12	ND
North Trench #3, East Wall	24	ND
North Trench #3, East Wall	36	ND
North Trench #3, East Wall	48	ND
North Trench #3, East Wall	60	ND

TABLE 6

(Page 2 of 2)

TRITIUM IN SOIL AT SPILL AREA AFTER DECONTAMINATION – OCTOBER 1976

Sample Identification	Sampling Depth (in.)	pCi/ml in Soil Moisture
North Trench #3, S. E. Wall	12	11
North Trench #3, S. E. Wall	24	23
North Trench #3, S. E. Wall	36	112
North Trench #3, S. E. Wall	48	50
North Trench #3, S. E. Wall	60	33
North Trench #3, S. W. Wall	12	10
North Trench #3, S. W. Wall	24	ND
North Trench #3, S. W. Wall	36	ND
North Trench #3, S. W. Wall	48	51
North Trench #3, S. W. Wall	60	ND
North Trench #3, West Wall	12	55
North Trench #3, West Wall	24	8
North Trench #3, West Wall	36	10
North Trench #3, West Wall	48	ND
North Trench #3, West Wall	60	ND

TABLE 7

TRITIUM IN DECONTAMINATION WORK AREA SOIL – OCTOBER 1976

Sample Identification	Sampling Depth (in.)	pCi/ml in Soil Moisture
DP-1	Surface	5,202
DP-1	12	6,288
DP-2	Surface	10,953
DP-2	12	1,628
DP-3	Surface	64.9
DP-3	12	2.9
DP-4	Surface	12.8
DP-4	12	4.4
DP-5	Surface	16.1
DP-5	12	5.5
DP-6	Surface	56.7
DP-6	12	ND
DP-7	Surface	14.8
DP-7	12	2.8
DP-8	Surface	4.9
DP-8	12	ND
DP-9	Surface	ND
DP-9	12	ND
DP-10	Surface	5.9
DP-10	12	ND
DP-11	Surface	6.0
DP-11	12	3.7
DP-12	Surface	10.9
DP-12	12	3.5
DP-13	Surface	8.2
DP-13	12	2.8
DP-14	Surface	ND
DP-14	12	ND
DP-15	Surface	4.5
DP-15	12	5.8
DP-16	Surface	12.1
DP-16	12	2.3
DP-17	Surface	25.4
DP-17	12	9.5
DP-18	Surface	35.3
DP-18	12	93
DP-19	Surface	35.7
DP-19	12	31.1
DP-20	Surface	54
DP-20	12	4.5
DP-21	Surface	17.1
DP-21	12	4.4
SP-1	Surface	73
SP-1	12	24.4
SP-2	Surface	24.3
SP-2	12	7.1
SP-3	Surface	10.3
SP-3	12	5.4
SP-4	Surface	17.8
SP-4	12	1.6

TABLE 8

TRITIUM IN SOIL AT R-E WELLHEAD – OCTOBER 1976

Sample Identification	Sampling Depth (in.)	pCi/ml in Soil Moisture
RE-1	Surface	4.9
RE-1	12	ND
RE-2	Surface	5.7
RE-2	12	ND
RE-3	Surface	6.7
RE-3	12	4.4
RE-4	Surface	ND
RE-4	12	ND

FIGURE 1. LOCATION MAP – PROJECT RULISON

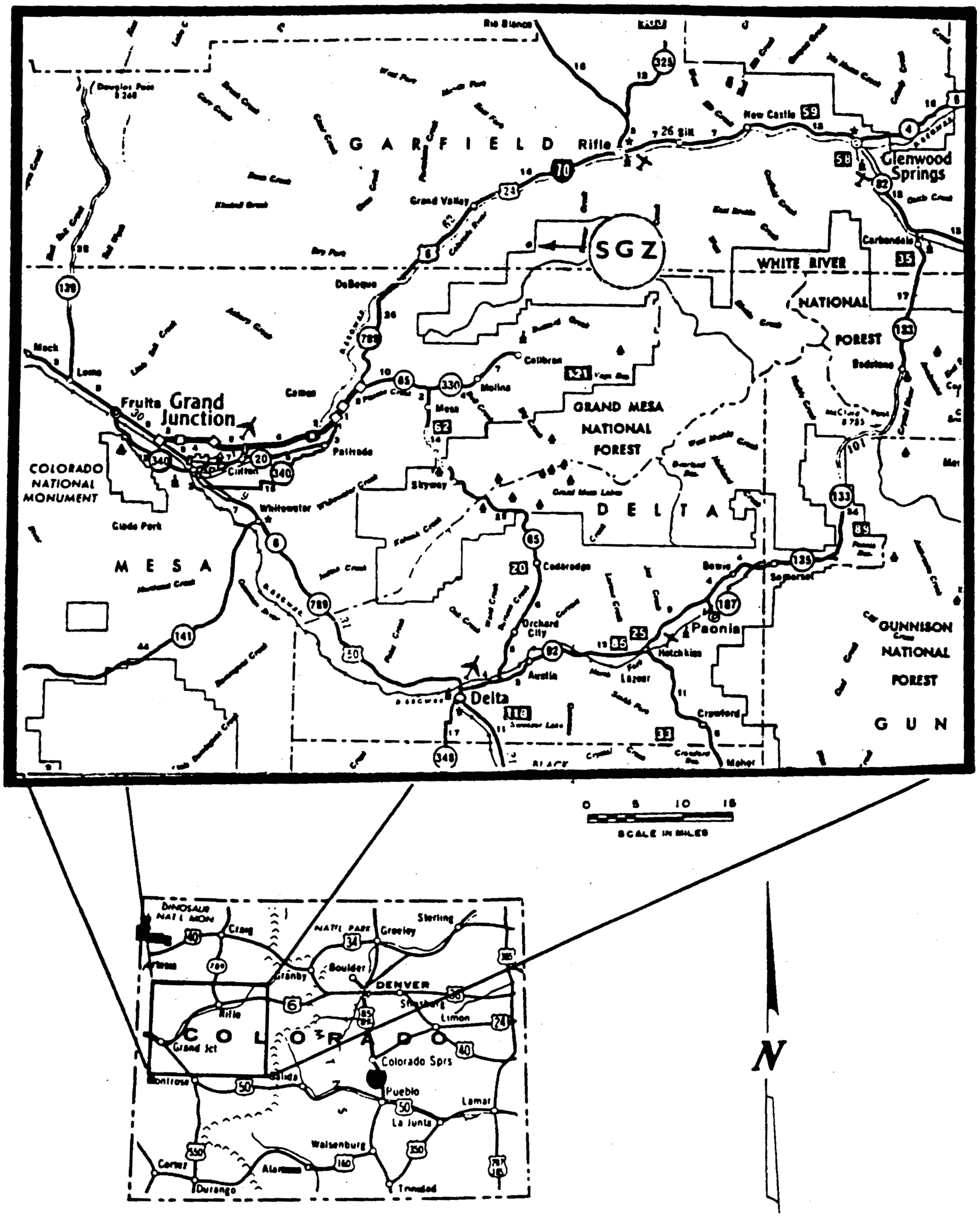


FIGURE 2. RULISON SITE AT COMPLETION OF FLARE TESTING

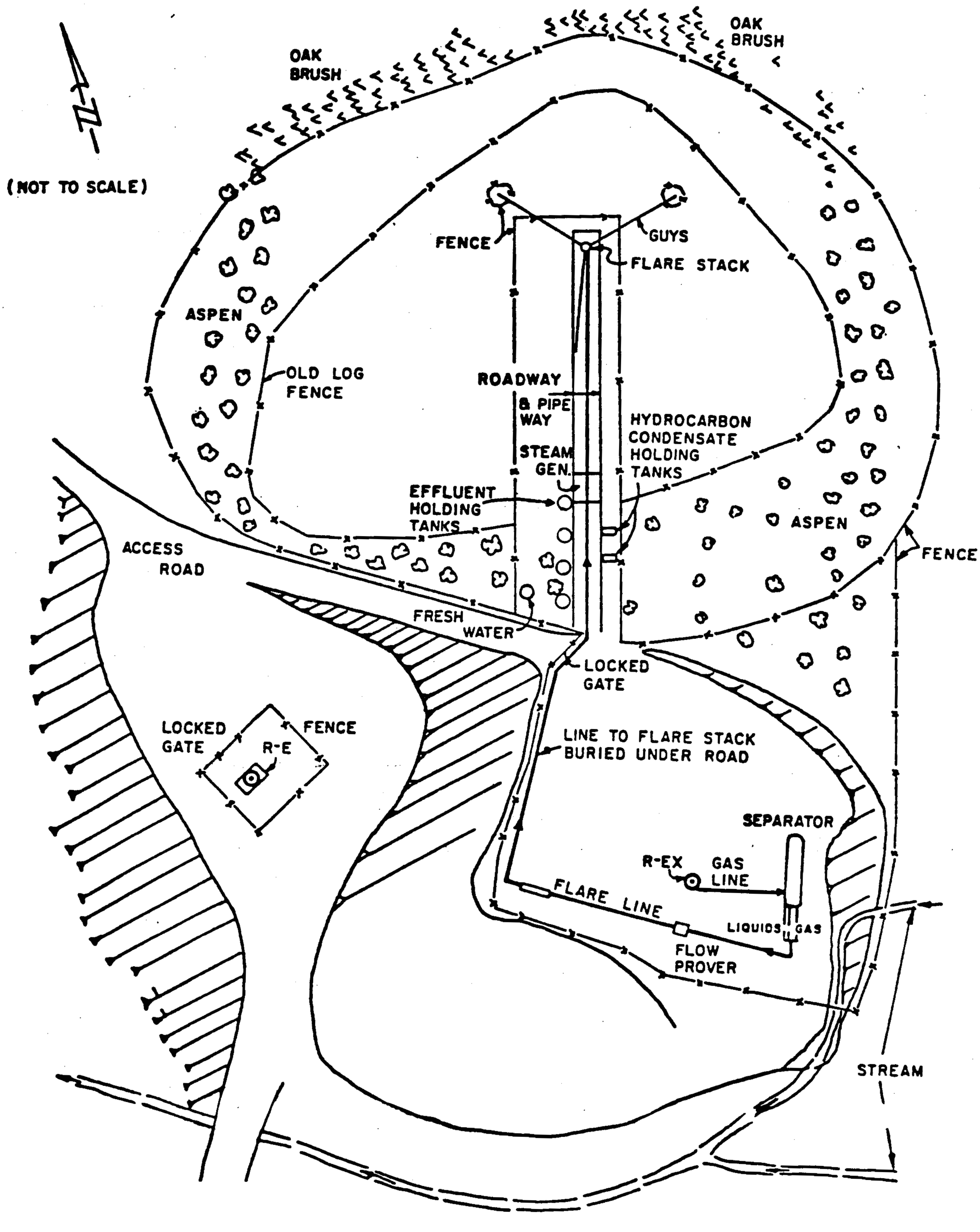
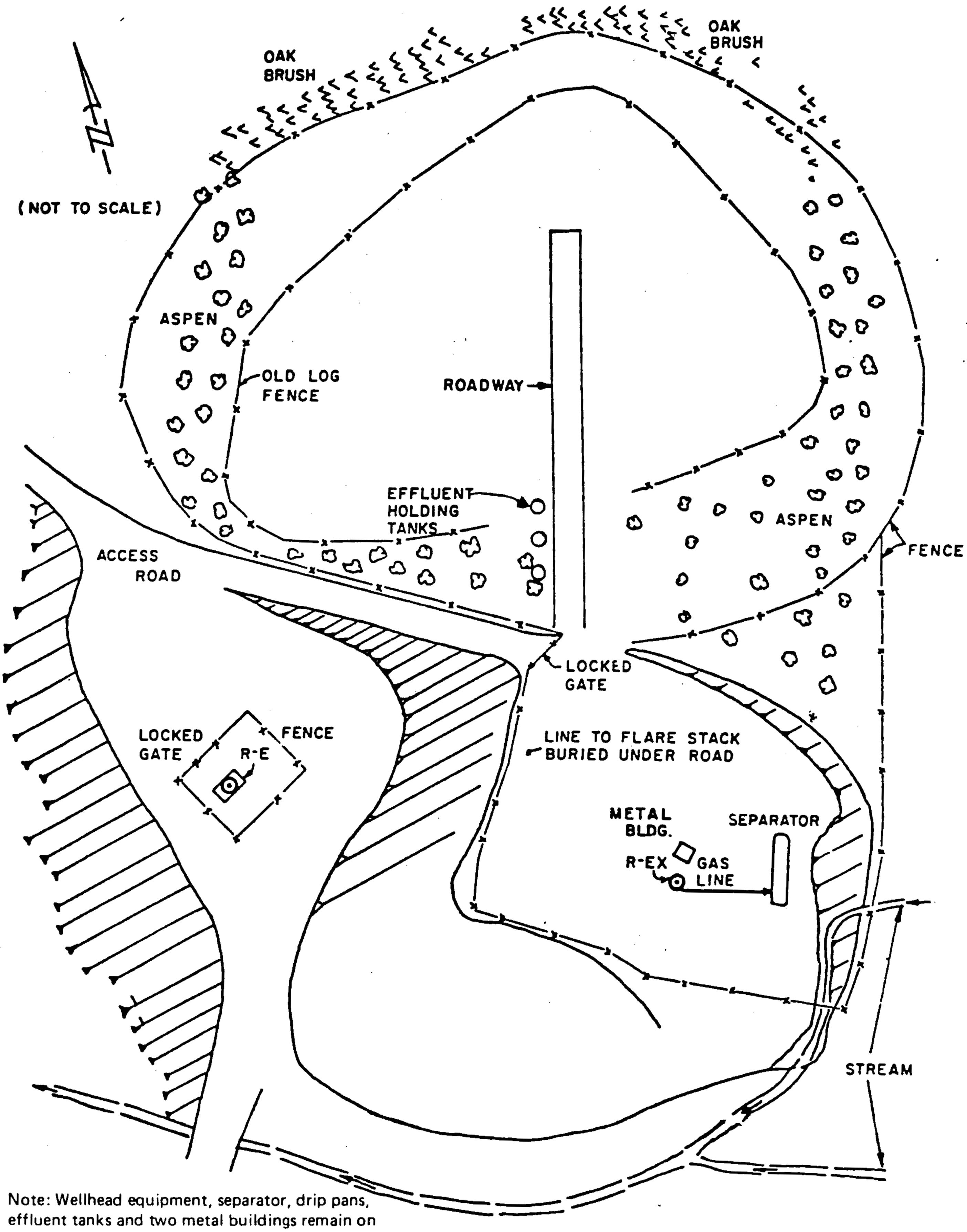


FIGURE 3. RULISON SITE AT COMPLETION OF THE GENERAL SITE CLEAN-UP EFFORT (JULY 1973)



Note: Wellhead equipment, separator, drip pans, effluent tanks and two metal buildings remain on site as of August 1973.

LEGEND

1. Symbols

■ Flare Stack

▲ Re-entry wellhead

ND – Non-detectable

2. Coding Example

6-20-4
Picocuries/Gram
Picocuries/ml in soil moisture
Depth in inches

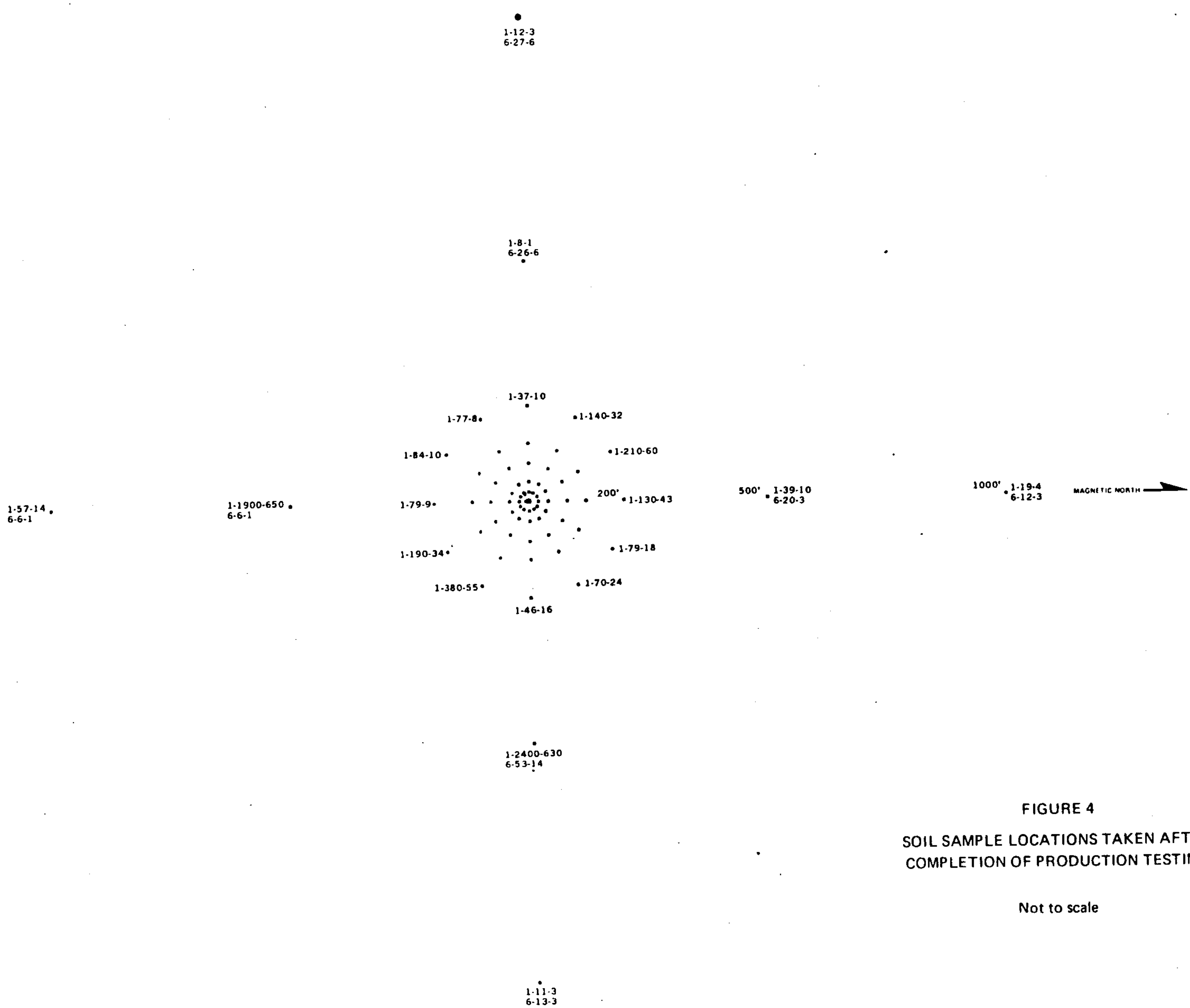


FIGURE 4

SOIL SAMPLE LOCATIONS TAKEN AFTER COMPLETION OF PRODUCTION TESTING

Not to scale

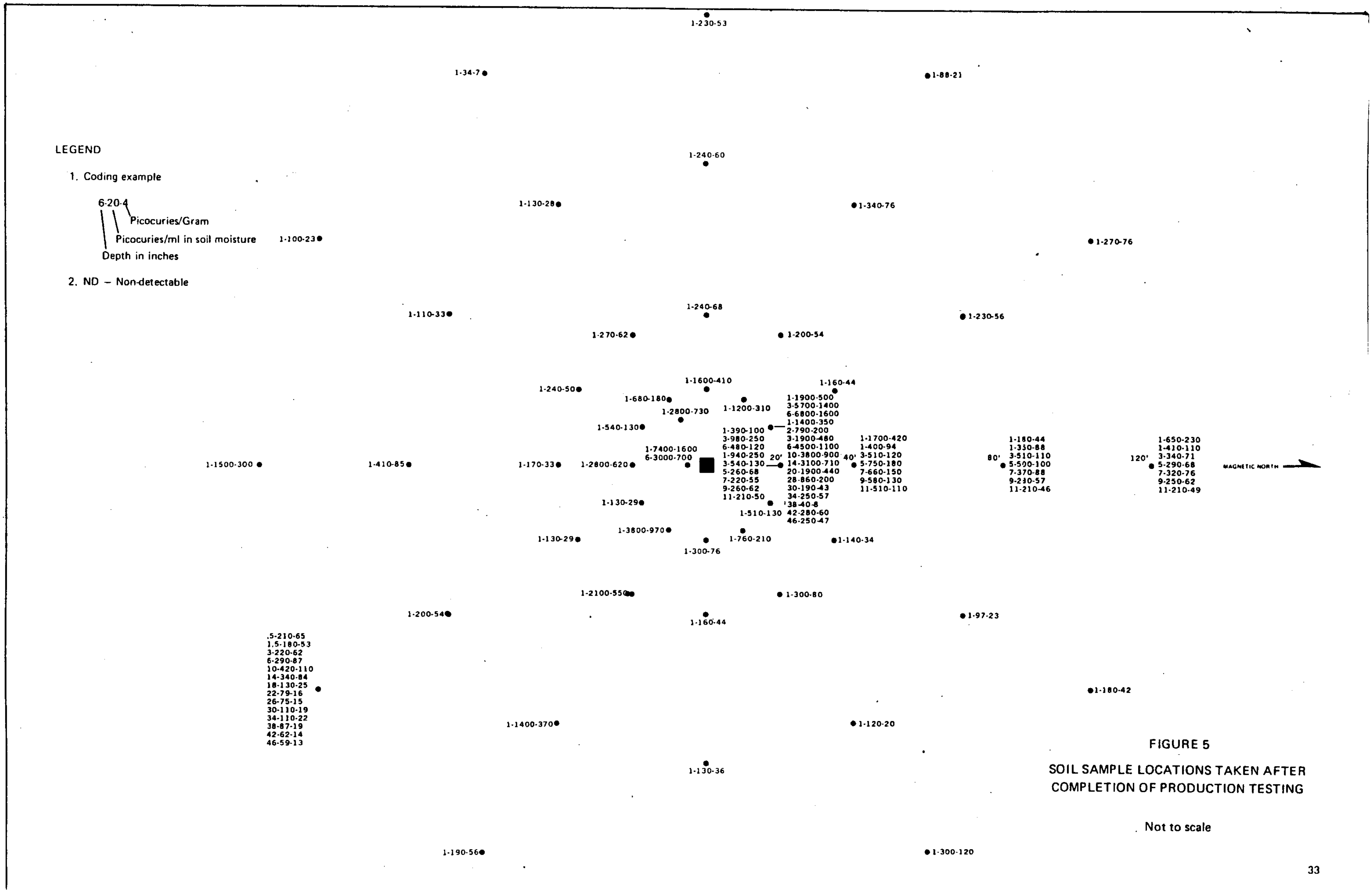


FIGURE 5

SOIL SAMPLE LOCATIONS TAKEN AFTER COMPLETION OF PRODUCTION TESTING

Not to scale

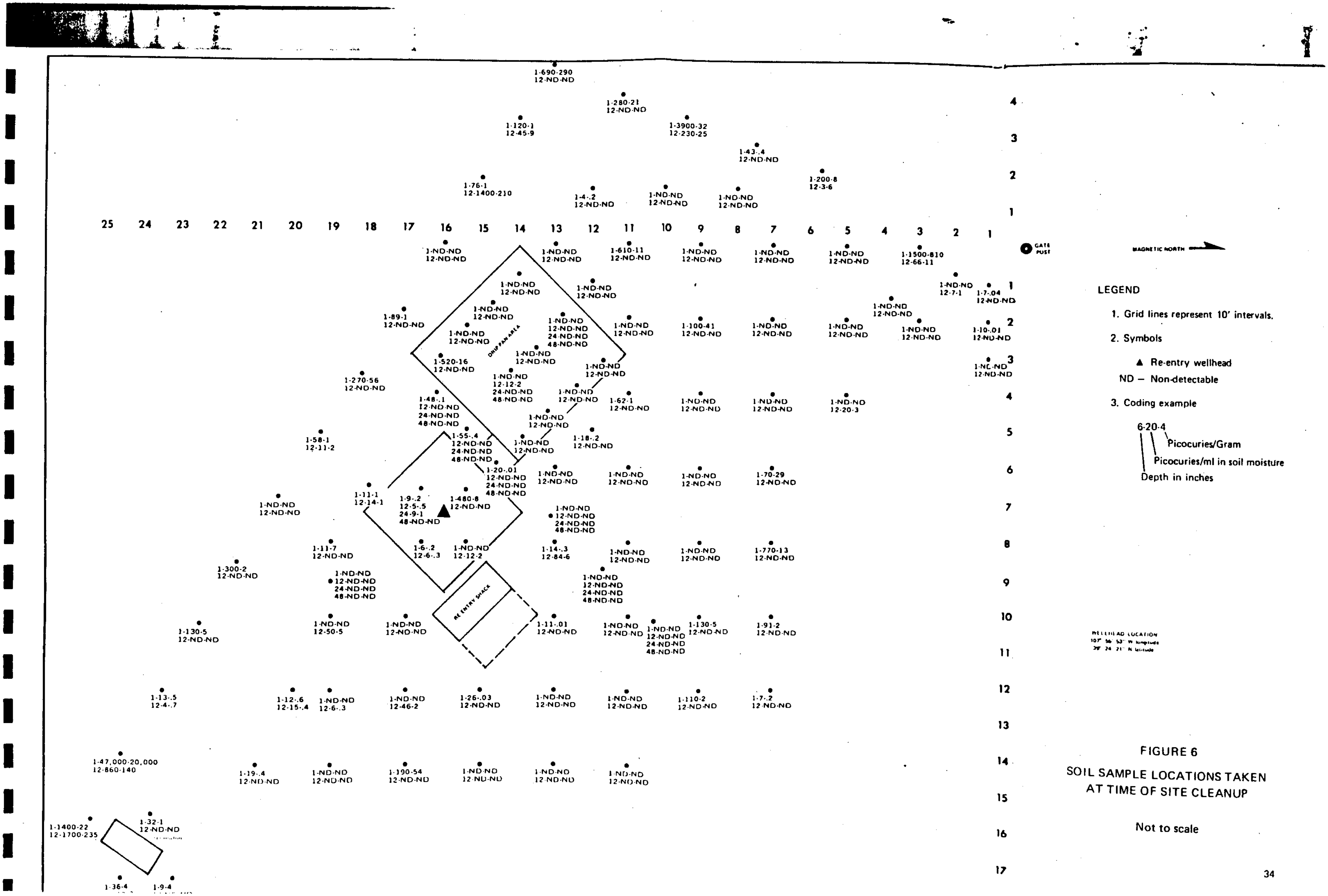
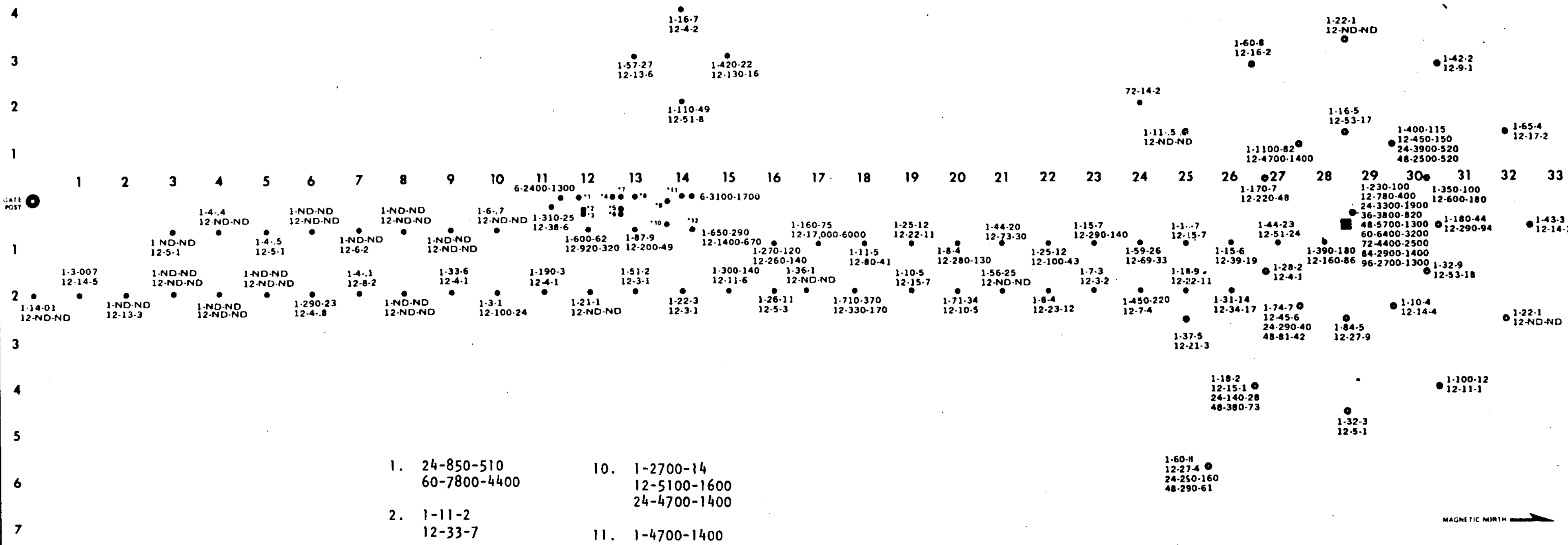


FIGURE 6

SOIL SAMPLE LOCATIONS TAKEN AT TIME OF SITE CLEANUP

Not to scale



1. 24-850-510
   60-7800-4400
2. 1-11-2
   12-33-7
3. 1-110-24
   12-93-22
4. 1-300-34
   12-12-15
5. 1-44-10
   12-ND-ND
6. 1-21-8
   12-11-5
7. 6-150-81
8. 12-73-41
   60-51-24
9. 1-10,000-1400
   12-20,000-5600
   24-21,000-5800
10. 1-2700-14
    12-5100-1600
    24-4700-1400
11. 1-4700-1400
    12-3300-1800
12. 1-8600-1500
    12-29,000-6500
    24-35,000-11,000
    36-34,000-19,000
    48-27,000-7300
    60-26,000-14,000
    72-18,000-9600
    96-8000-9600
    108-9700-2300
    120-5600-1400
    132-3300-600

LEGEND

1. Grid lines represent 10' intervals.
2. Symbols
   ■ Flare Stack
   ND – Non-detectable
   ⊙ Gate Post
3. Coding example

6-20-4
Picocuries/Gram
Picocuries/ml in soil moisture
Depth in inches

FIGURE 7

SOIL SAMPLE LOCATIONS TAKEN AT TIME OF SITE CLEANUP

Not to scale

FIGURE 8
SOIL SAMPLING, RULISON TANK AREA, OCTOBER 1976
pCi/ml ^3H IN SOIL MOISTURE

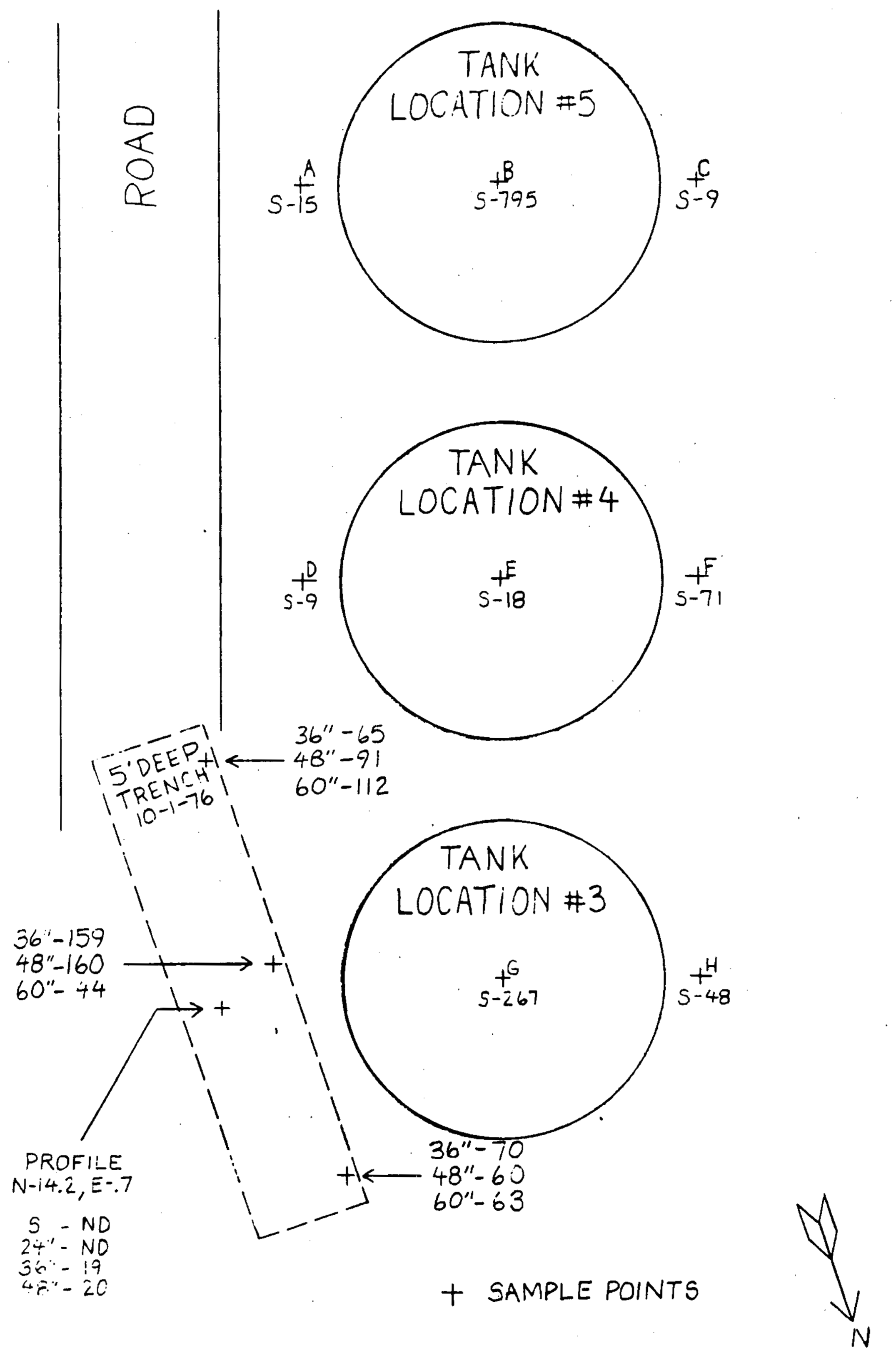
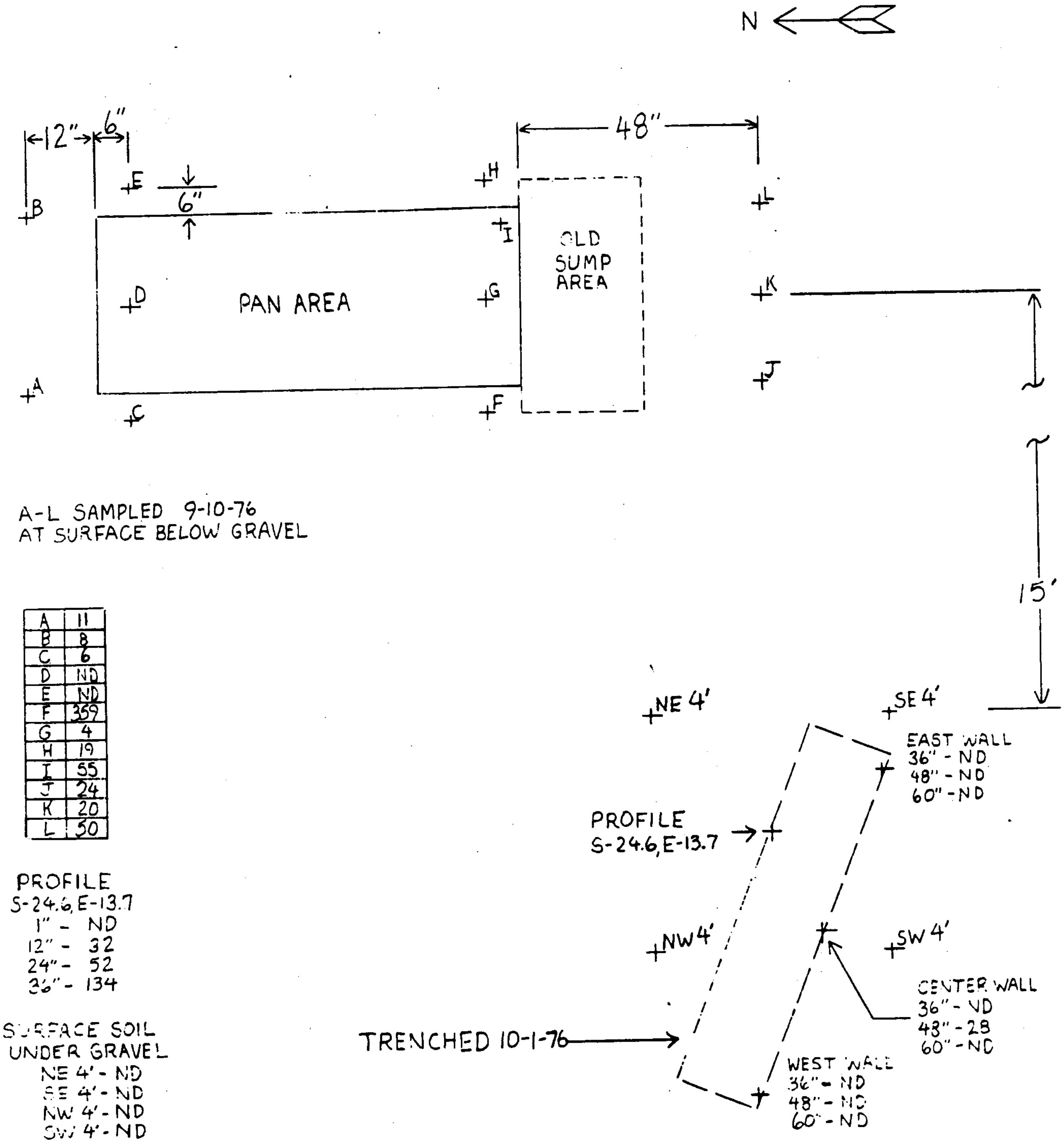


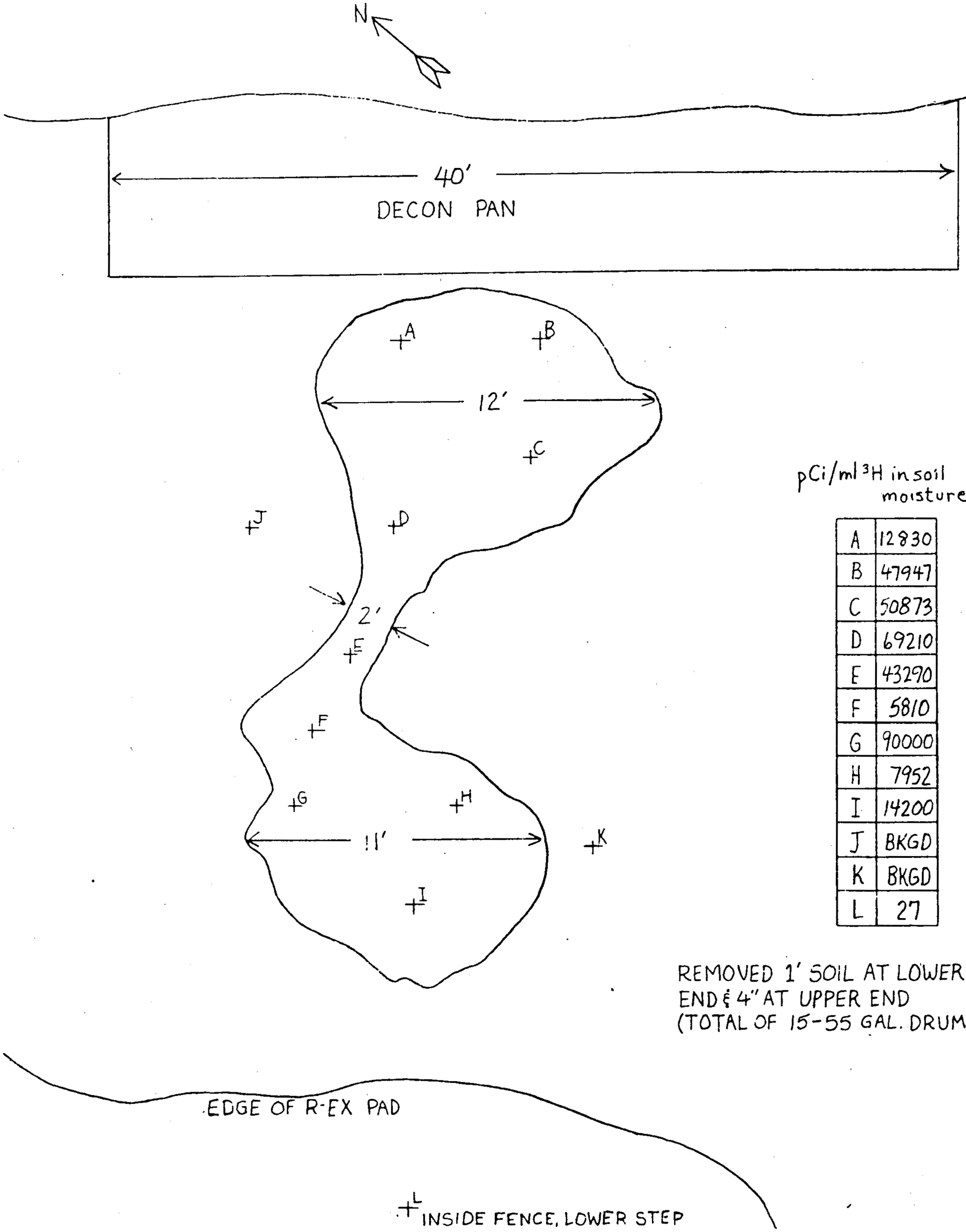
FIGURE 9
RULISON SEPARATOR PAN AREA (PREVIOUS PIPE SPILL)
SEPTEMBER 30, 1976
pCi/ml ^3H IN SOIL MOISTURE



A	11
B	8
C	6
D	ND
E	ND
F	359
G	4
H	19
I	55
J	24
K	20
L	50

FIGURE 10A

RULISON SEPARATOR SPILL, SEPTEMBER 1, 1976



pCi/ml ^3H in soil moisture

A	12830
B	47947
C	50873
D	69210
E	43290
F	5810
G	90000
H	7952
I	14200
J	BKGD
K	BKGD
L	27

REMOVED 1' SOIL AT LOWER END & 4" AT UPPER END (TOTAL OF 15-55 GAL. DRUMS)

FIGURE 10B
RULISON SEPARATOR SPILL SURVEY, SEPTEMBER 16, 1976
AFTER 15 DRUM SOIL REMOVAL

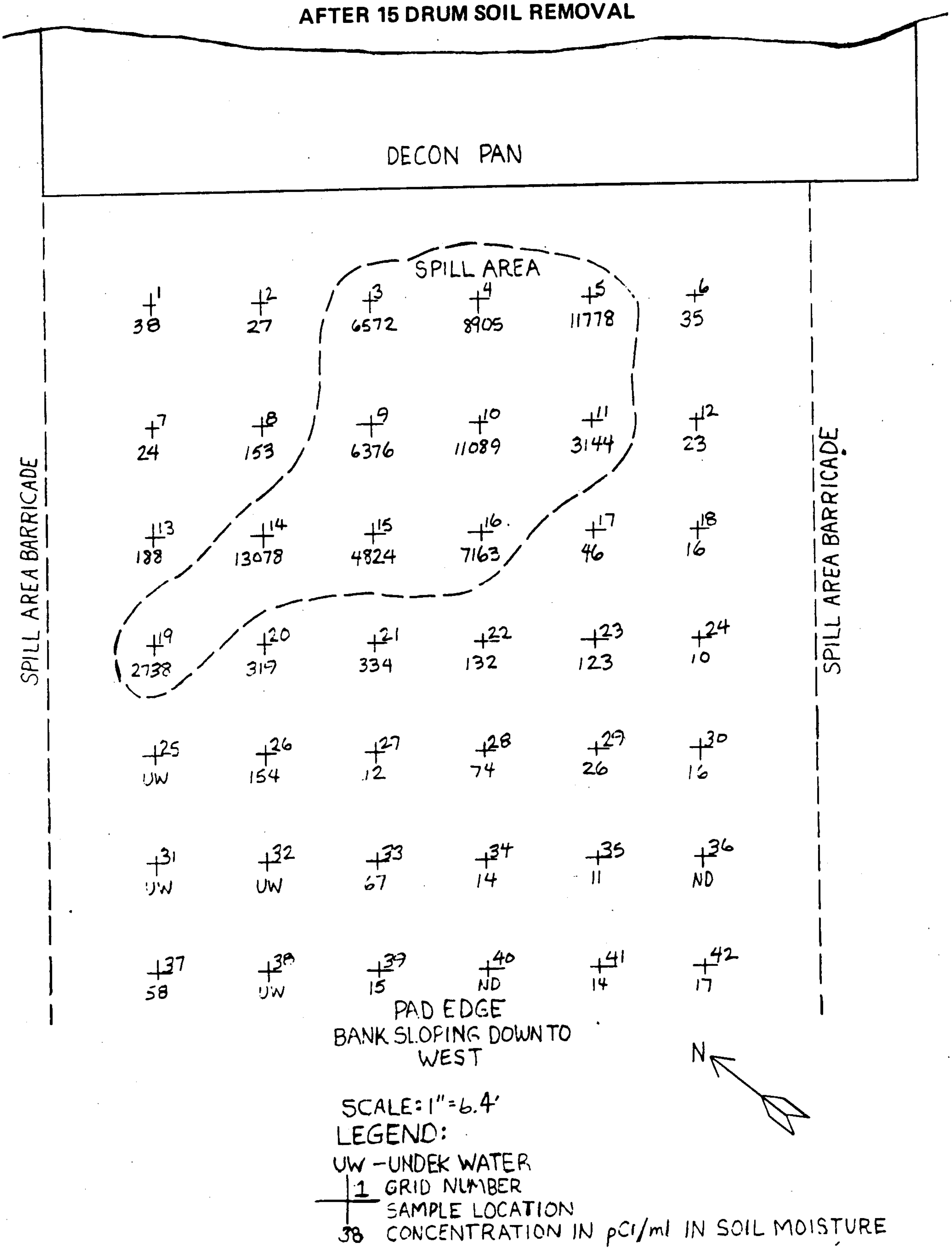
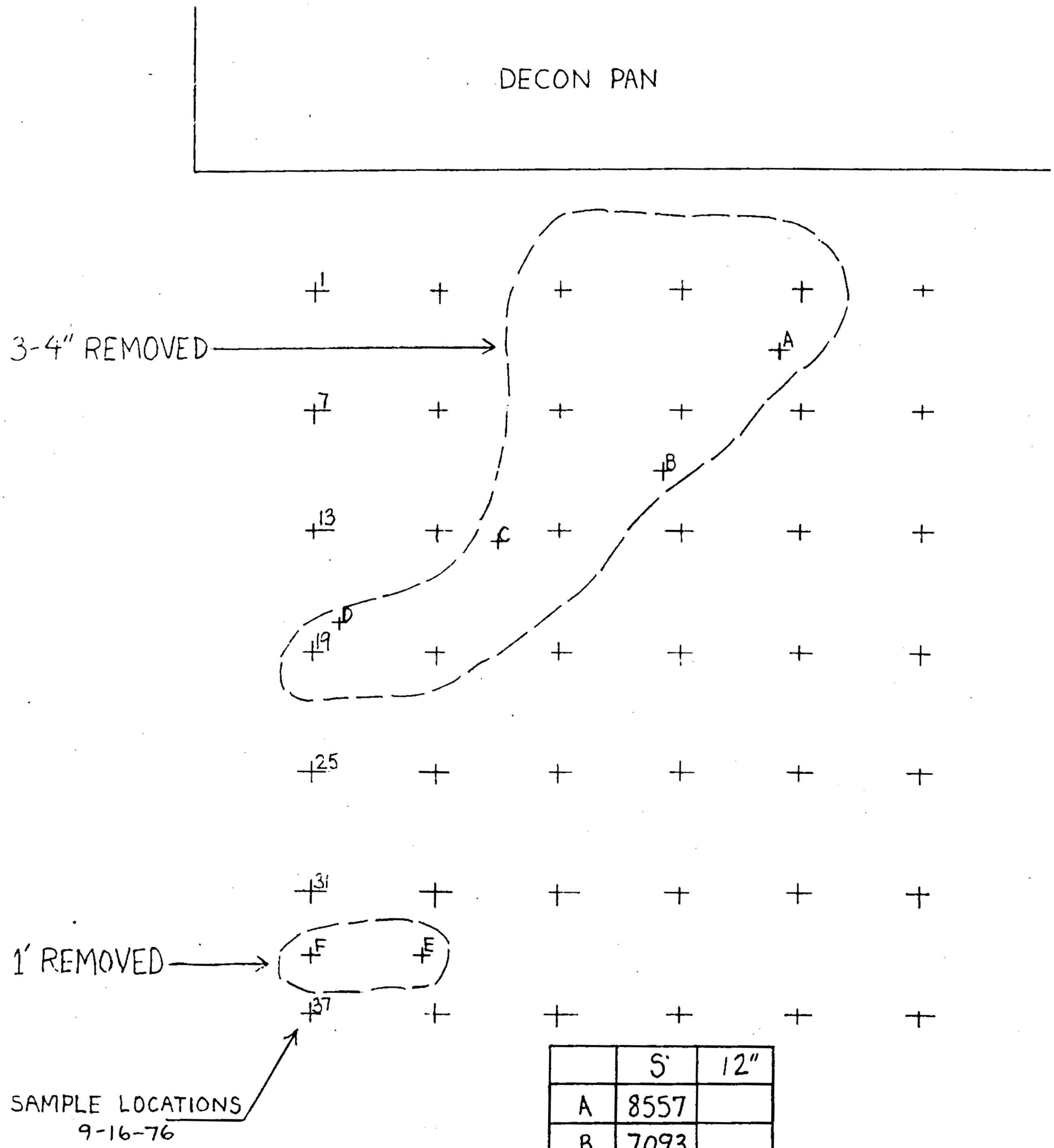
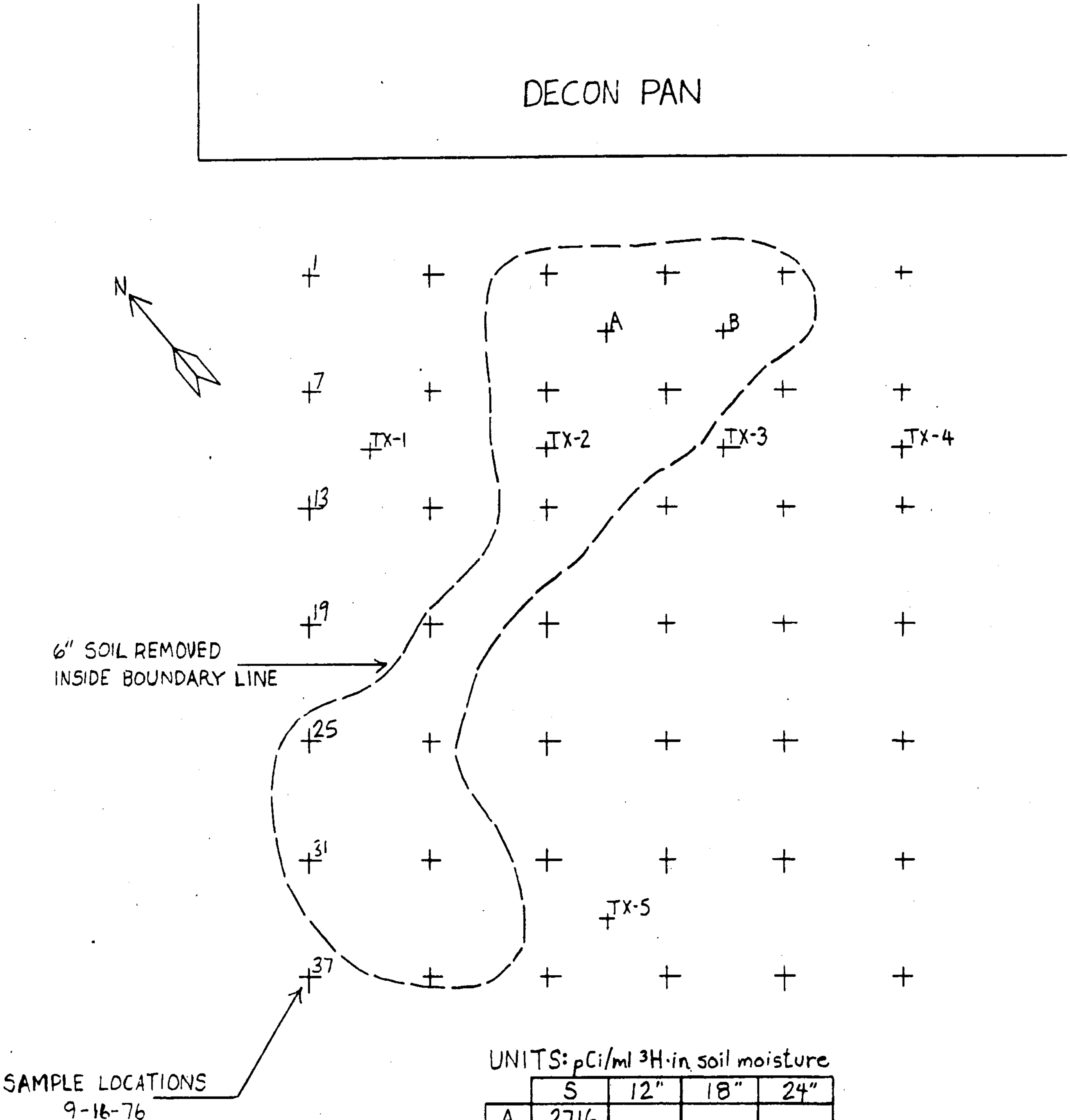


FIGURE 10C
RULISON SEPARATOR SPILL, SEPTEMBER 21, 1976
AFTER REMOVAL OF 5 ADDITIONAL DRUMS OF SOIL
UNITS: pCi/ml ^{3}H IN SOIL MOISTURE



	S	12"
A	8557	
B	7093	
C	18786	27718
D	3435	
E	589	
F	2311	

FIGURE 10D
RULISON SEPARATOR SPILL, SEPTEMBER 23, 1976
(VERTICAL PROFILE HOLES ON TRANSECT)

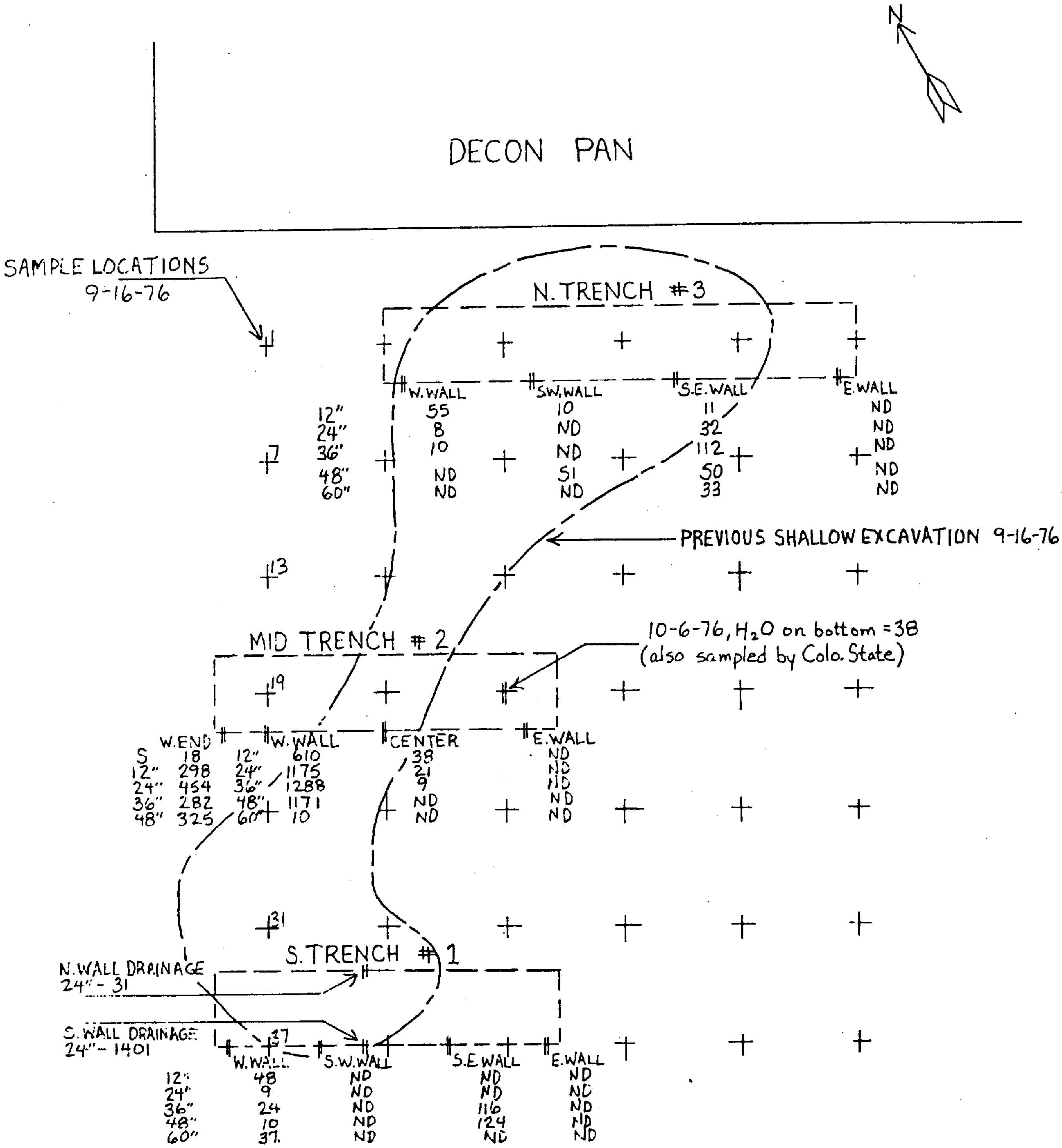


UNITS: pCi/ml ^3H in soil moisture

	S	12"	18"	24"
A	2716			
B	5172			
TX-1	96	ND	ND	15
TX-2	446	33	27	21
TX-3	85.7	ND	ND	ND
TX-4	21.7	22.2	ND	ND
TX-5	ND	ND	ND	ND

FIGURE 10E

RULISON SEPARATOR SPILL (TRENCHES), OCTOBER 1, 1976



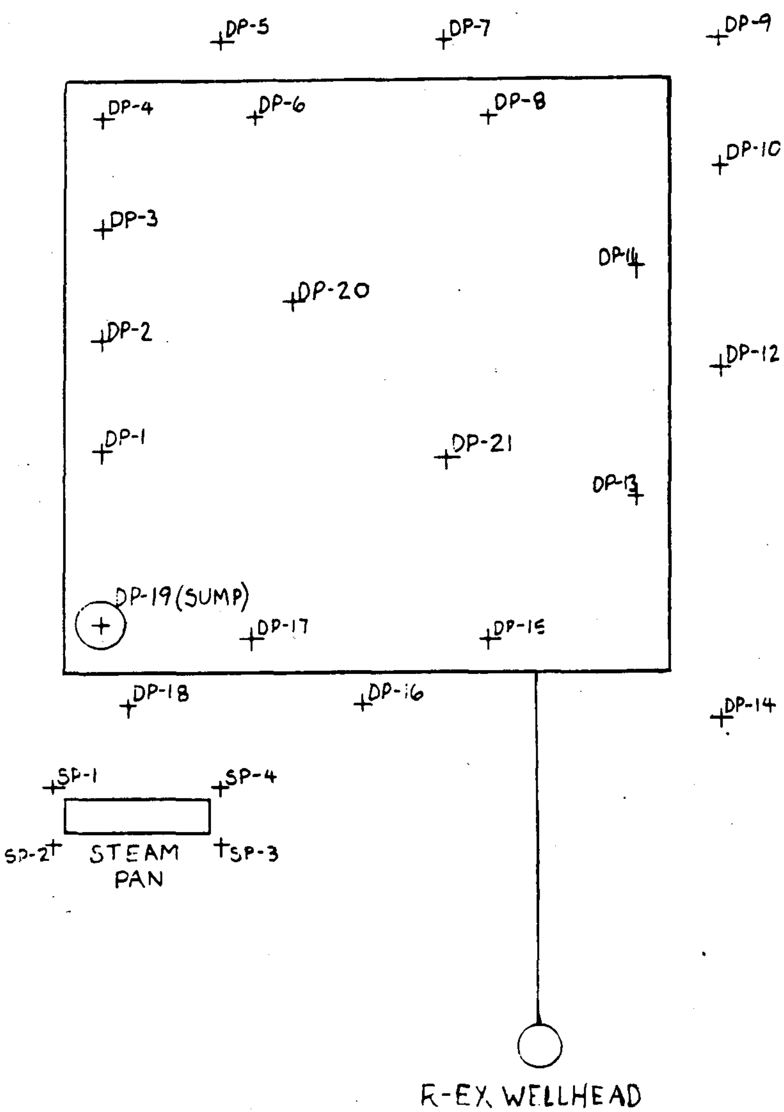
UNITS: pCi/ml ^3H in soil moisture

FIGURE 11

RULISON SOIL SAMPLING (R-EX DECONPAN AREA), OCTOBER 7, 1976

UNITS: pCi/ml ^3H IN SOIL MOISTURE

N



SITE	S	12"
SP-1	73	24.4
-2	24.3	7.1
-3	10.3	5.4
SP-4	17.8	1.6
DP-1	5202	6288
-2	10953	1628
-3	64.9	2.9
-4	12.8	4.4
-5	16.1	5.5
-6	56.7	ND
-7	14.8	2.8
-8	4.9	ND
-9	ND	ND
-10	5.9	ND
-11	6.0	3.7
-12	10.9	3.5
-13	6.2	2.8
-14	ND	ND
-15	4.5	5.8
-16	12.1	2.3
-17	25.4	9.5
-18	35.3	93
-19	35.7	31.1
-20	54	4.5
DP-21	17.1	4.4

FIGURE 12

RULISON-RE WELLHEAD CELLAR AREA, OCTOBER 7, 1976

pCi/ml ^3H IN SOIL MOISTURE